Appendix 9 – Flora and Vegetation Management Plan

Alcoa of Australia Limited

Flora and Vegetation Management Plan Huntly and Willowdale Mines

August 2023

Version	Description of Changes	Date
0	EMMP Version	31/08/2023

Contents

Tables

Appendices

GLOSSARY

TERMS	DESCRIPTION
Adverse	Impacts likely to change the conservation status or significantly change the local population numbers of a species
Conservation significant	Environmental values which are protected by legislation or are considered to be of ecological importance, which includes: • Threatened Flora under BC Act and EPBC Act • Priority Flora • Significant species (novel species, range extensions, and restricted occurrences) • Vegetation types which support conservation significant flora species • Threatened ecological communities. • Priority ecological communities • State forest • Old growth forest
Direct impact	Impact through direct loss of conservation significant flora and vegetation from vegetation clearing
Indirect impact	Effects which are considered to potentially reduce the health of flora and vegetation including: • dust, during construction and mining operations • intensification and spread of dieback. • weed infestation during construction and mining operations. • Change in fire regimes. Individuals within a 50m buffer of the proposed mine layout, whereby potential indirect impacts may be predominantly more apparent to flora and vegetation. This is based on the DWER Clearing Regulation Fact Sheet 24: Environmentally Sensitive Areas (August 2014), whereby a declared environmentally sensitive area is considered the area covered by vegetation within 50 m of rare flora, to the extent to which the vegetation is continuous with the vegetation in which the rare flora is located.
Mining Avoidance Zone	Spatial area which prohibits mine pits and infrastructure, with the exception of monitoring and management activities which have minimal impacts
Mining Exclusion Zone	Spatial area which prohibits mine pits
Plant condition	Qualitative measure of the condition of single plants based on leaf colour, new growth, foliage cover and general plant vigour.
Plant health	Quantitative measures of plant physiological function
Rate of mortality	Individual plant mortalities over time
Significant	Adverse impacts to a species' local population or conservation significance rating
Weeds	Flora species that are non-native to the biogregion
Unauthorised clearing	Clearing of vegetation or individual flora species without an approved internal clearing permit.
ABBREVIATIONS	DESCRIPTION

TERMS	DESCRIPTION
AER	Annual Environmental Report
BAM	*Biosecurity and Agriculture Management Act 2007*
BC Act	*Biodiversity Conservation Act 2016 (WA)*
DBCA	Department of Biodiversity, Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DFES	Department of Fire and Emergency Services
DPAW	Department of Parks and Wildlife
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986 (WA)*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999 (Cth)*
FCA	Forest Clearing Advice
MCMPR	Ministerial Council on Mineral and Petroleum Resources
MMP	Mining and Management Program
MMPLG	Mining and Management Program Liaison Group
MNES	Matter of National Environmental Significance
WONS	Weeds of National Significance

1 Executive Summary

This Flora and Vegetation Management Plan (FVMP) has been prepared for the Huntly and Willowdale bauxite mines located within Alcoa's Mining Lease 1SA (ML1SA).

This FVMP specifically addresses management of the risks and impact of bauxite mining on key environmental values associated with Flora and Vegetation Environmental Factor consisting of:

- Threatened and priority flora species.
- Priority Ecological Communities.
- Threatened Ecological Communities.

Summary Table 1-1 below presents the environmental objectives for the environmental factor to be met through implementation of this FVMP, as well as the environmental criteria and management targets to measure achievement of the associated environmental objectives.

Table 1-1: Environmental criteria to measure achievement of environmental objectives

EMP Name	Flora and Vegetation Management Plan
Proponent Name	Alcoa of Australia Limited
Ministerial Statement Number	Willowdale Mine (Wagerup Refinery): • Ministerial Statement 1157 (preceding statements: 728, 897, 1069) Huntly Mine (Kwinana and Pinjarra Refinery): • Ministerial Statement 646
State Agreements	• Alumina Refinery (Kwinana) Agreement Act 1961 • Alumina Refinery (Wagerup) Agreement Act and Acts Amendment Act 1978 • Alumina Refinery (Pinjarra) Agreement Act 1969 • Alumina Refinery (Alcoa) Amendment Act 1987
Purpose of this EMP	*To protect flora and vegetation so that biological diversity and ecological integrity are maintained.*
Key Environmental Factor/s, outcome/s and/or objectives	Flora and Vegetation EPA Objective: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained*
Management based provisions	**Environmental Objective** • Minimise direct loss of conservation significant flora, vegetation and communities from mining and construction activities. • Minimise the fragmentation of vegetation and landforms that support conservation significant flora and vegetation. • Upon rehabilitation completion, establish a self-sustaining jarrah forest ecosystem. • Minimise indirect impacts on flora, vegetation, and communities outside the approved clearing boundary.

	Management Target/s • No significant impacts to conservation significant flora populations, vegetation or communities as a result of clearing activities (including fragmentation). • No clearing of threatened flora individuals or communities without regulatory consultation and appropriate approvals. • Rehabilitated areas meet relevant completion criteria. • No reduction in quality of conservation significant flora or communities resulting from dust deposition. • No reduction in quality of conservation significant flora or communities resulting from introduction or spread of weeds, Phytophthora dieback or other forest diseases or fire. • No significant impact to surface water values as a result of hydrological regime changes from mining activities. • No significant impact to groundwater values as a result of hydrogeological regime changes from mining activities.
Proposed construction date	Not applicable
EMP required pre-construction	Not applicable

2 Context, Scope and Rationale

This Flora and Vegetation Management Plan (FVMP) has been prepared for management of flora and vegetation values at the Huntly and Willowdale bauxite mines located within Alcoa's Mining Lease 1SA (ML1SA) in the Northern Jarrah Forest (NJF).

This FVMP has been developed to address the environmental management of conservation significant flora and vegetation, in accordance with

- Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016 (EPA 2016)
- Environmental Protection Authority's (EPA) Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans (EPA 2021)

2.1 Huntly and Willowdale Mine Regions

Alcoa of Australia Limited's (Alcoa) Western Australian (WA) mining operations comprise the Huntly and Willowdale bauxite mines, which are located in Alcoa's Mining Lease 1SA (ML1SA) within the Northern Jarrah Forest (NJF) IBRA subregion.

The Huntly Mine supplies bauxite to the Kwinana and Pinjarra alumina refineries and for export. The Huntly Mine has operated since 1972, initially as the Del Park Mine, over six mine regions with a further two regions proposed (Table -1). This FVMP addresses all eight regions including current and future operations and past and future rehabilitation.

Table 2-1: Huntly Mine Regions

Mine region	Region area (ha)	Status	Years of operation
Del Park	3,507	Historic	1972-1987
Huntly 1&2	4,570	Historic	1986-1997
White	12,349	Historic	1989-2006
McCoy	15,512	Historic	2003-2015
O'Neil	12,838	Current	2010-2015 2023-2025
Myara	20,829	Current	2014-present 2023-2025
Myara North	18,172	Proposed	~ 2025-2030
Holyoake	9,157	Proposed	~ 2030-2035

The Huntly Mine is predominantly located within the Shire of Serpentine-Jarrahdale and the Shire of Murray, extending from Dwellingup in the south to Jarrahdale in the north. The Huntly Mine lies within Dwellingup and Jarrahdale State Forest. The Huntly Mine is broadly bordered by Serpentine National Park and the Darling Scarp to the west, the Monadnocks Conservation Park and Albany Highway to

the east, Dwellingup and Pinjarra-Williams Road to the south and the former Jarrahdale Mine to the north.

To the north of the Huntly Mine (Myara North region) lies the former Jarrahdale Mine, which was operated from 1963 and 1998 and is now closed and rehabilitated. This EMP does not address the former Jarrahdale Mine.

The Willowdale Mine supplies bauxite to the Wagerup Alumina Refinery. The Willowdale Mine has operated since 1984 over three regions (Table 2-2).

Table 2-2: Willowdale Mine regions

Mine region	Region area (ha)	Status	Years of operation
Arundel	6,102	Historic	1984-2000
Orion	23,149	Historic	2000-2021
Larego	23,422	Current	2021-current 2023-2045 proposed

The Willowdale Mine is located within the Shire of Waroona and Shire of Harvey and is broadly bordered by Lane Poole Reserve in the east and north-east, the Darling Scarp to the west, and Harvey Dam and surrounding rural land to the south-east. The Willowdale Mine lies predominantly within Dwellingup State Forest and Lane Poole Reserve.

Implementation and operation of the mines may impact conservation significant flora species and vegetation types. This FVMP has been prepared to outline Alcoa's approach to managing environmental impacts on conservation significant flora and vegetation values.

The FVMP has been prepared in accordance with the *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA 2021).

This FVMP addresses all phases of the WA Mining Operations including:

- Exploration
- Construction
- Mining
- Rehabilitation

2.2 Key Environmental Factors

This FVMP has been developed to meet the EPA's flora and vegetation environmental factors including the factor objective and relevant policy and guidance. The EPA's objective for flora and vegetation is: "*To protect flora and vegetation so that biological diversity and ecological integrity are maintained*."

In the context of this objective *ecological integrity* is the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements (EPA 2016).

Table 2-3 presents the region-specific environmental values for flora and vegetation values at the Huntly and Willowdale mines and the potential impacts to these values from Alcoa's activities.

Table 2-3: Key flora and vegetation environmental values, impacts and controls as addressed in this FVMP

Flora and Vegetation Environmental Value	Potential impacts (direct/ indirect)
• Threatened Flora under BC Act and EPBC Act • Priority Flora • Significant Species (novel species, range extensions and restricted occurrences) • Vegetation types which support conservation significant flora species • Threatened ecological communities. • Priority ecological communities • State Forest • Old growth forest	• Direct loss of flora individuals and vegetation • Loss of vegetation • Reduction in critical habitat • Loss of conservation significant vegetation, communities and flora individuals • Decline in health and/or change in flora and vegetation composition. • Population fragmentation • Permanent / long term loss of vegetation quality • Fragmentation or isolation of conservation significant populations or occurrences (indirect) • Introduction or promotion of weeds and/or disease, and temporary impacts such as fire • Altered hydrology, including alteration of surface water flow and groundwater level.

2.3 Condition Requirements

The following environmental management commitments, outlined in Schedule 2 of MS728 (as amended by MS897, MS1069 and MS1157) relate to flora and vegetation management within ML1SA:

- (3): Alcoa will plan and manage its mining operations to minimise disturbance to biologically diverse areas fringing major rock outcrops and stream zones. Appropriate buffers will be maintained between these areas and mine pit boundaries. Stream crossings will be constructed in a manner which facilitates their removal and rehabilitation after use, unless required for ongoing forest management or other purposes agreed with the State's Mining and Management Program Liaison Group (MMPLG).
- (4): Alcoa will continue its program of biological surveys and support of activities contributing to the conservation of rare, endangered and priority species and communities existing within the vicinity of its mining operations.
- (6): Alcoa will monitor the success of all its rehabilitated mined areas in consultation with the Department of Environment and Conservation
- (7): Alcoa will forego the bauxite resources in the jarrah forest conservation areas agreed in consultation with the State's Reserves Review Committee and specified in the Alumina Refinery Agreement Amendment Act, No 99 or 1986, for as long as their conservation values remain. Mining adjacent to the conservation areas will utilise site-specific environmental management procedures agreed in consultation with the MMPLG. These will include particular consideration of dieback management and mine rehabilitation requirements.

- (8): Alcoa will defer mining indefinitely the bauxite resources in the facilities section of the recreation zone of the Lane Poole Reserve as defined in Figure 10 of the 1994 Consultative Environmental Review. Ore extraction in the remaining areas of the recreation zone will exclude the steep slopes of the Murray River valley and will be undertaken in accordance with site-specific environmental management procedures agreed with the State's MMPLG after consultation with the Department of Environment and Conservation and the Lane Poole Reserve Advisory Committee.
- (9): Alcoa will implementation a comprehensive dieback management program designed specifically for its mine operations in the jarrah forest. This will include the rehabilitation of dieback-affected areas adjacent to its mine operating areas, in accordance with procedures agreed with State agencies, and irrespective of the cause of introduction of the disease.
- (10): Alcoa is committed to an ongoing research program into all aspects of its operation that have the potential to adversely affect the environment, and into those environmental characteristics that could be adversely affected by its operations.
- (11): Alcoa will submit a brief review of its research and management program to the Department of Industry and Resources on an annual basis. Copies will be made available to relevant State agencies and the Shire of Waroona. A more detailed review will be prepared on a triennial basis.

In 1995, the procedures of MS390 approval of Alcoa's Wagerup refinery expansion to 3.3 million tonnes defined the requirements for development of completion criteria for rehabilitation. The condition delegated responsibility for development of the completion criteria program to the Mining and Management Program Liaison Group (MMPLG). In 2006, these procedures were updated and superseded by MS728 approval of Alcoa's Wagerup refinery expansion to a maximum production capacity of 4.7 million tonnes per annum. The procedures require:

1. *Final rehabilitation completion criteria*
2. *The proponent and the Mining and Management Program Liaison Group shall regularly review and revise the final rehabilitation criteria, using procedures 4(2) and 4(3).*
3. *The review of the final rehabilitation completion criteria shall include public consultation.*
4. *The revised final rehabilitation completion criteria shall be made publicly available.*
5. *Best practice principles shall be applied.*

The Rehabilitation Completion Criteria identifies the standards that post mining rehabilitation must meet to ensure that landforms are stable and self-sustaining. Once completion criteria for mining area are met, Alcoa may then apply to hand over ownership of the land to the State Government. The rehabilitation is required to meet the standards of the day.

The completion criteria for different periods are:

- Completion criteria for early era (pre-1988)
- Rehabilitation Completion Criteria for 1988-2004
- Rehabilitation Completion Criteria for 2005-2014 Rehabilitation Completion Criteria for 2016 Onwards (as shown in Table 2-4)

Completion Criteria checklists can be located in Alcoa's controlled document system.

Table 2-4: Flora and Vegetation relevant Rehabilitation Completion Criteria for 2016 onwards

First 5 years		
Vegetation Establishment	The overstorey stocking of both jarrah and marri to meet standards.	- Minimum: 600 Eucalypt stems/ha - Maximum: 1400 Eucalypt stems/ha - Target: 1000 Eucalypt stems/ha (Except haul roads and pits <2ha) - Minimum: 200 Marri stems/ha - Minimum: 150 Jarrah stems/ha
	There is an adequate legume density in early regeneration.	Minimum legumes 0.5 per m^2 averaged over a pit assessed at 9 months.
	There is adequate plant species richness.	Species richness in monitoring plots in rehabilitated areas to be ≥60% of the average species richness in monitoring plots in unmined forest. Based on 15 months of growth.
	There is an adequate density of resprouter species.	Minimum number of surviving resprouter species will be 200 plants/ha.
Resilience of Vegetation	No introduction of weeds or that weed competition is restraining development of native species.	Vegetation establishment monitoring undertaken at 9 and 15 months.
Vegetation 12 years or older		
Resilience of Vegetation	The rehabilitation is capable of persisting at the required standard following bushfire.	A minimum of 300 stems/ha including: a minimum 150 stems/ha Jarrah; and a minimum 45 stems/ha Marri.
	Overstorey tree species not susceptible to dieback.	Minimum 200 Marri stems/ha at 9 months monitoring.
	Rehabilitation is not preferentially attacked by non-dieback forest diseases.	The disease expression in rehabilitation is no greater than in the un-mined forest.
	Rehabilitation is not preferentially attacked by insects.	The infestation of rehabilitation by insects is no greater than in the un-mined forest.
	Drought.	There is no obvious variation to the un-mined forest.

2.4 Rationale and Approach

This FVMP provides provisions for potential impacts to conservation significant flora and vegetation values specific to Alcoa operational activities.

2.4.1 Survey and study findings

As a part of the mine planning process, a range of surveys are undertaken at the earliest possible stage prior to mine development to assess potential impacts on heritage sites, flora, vegetation and fauna.

Surveys which address the assessment of Aboriginal heritage values, fauna values, and *Phytophthora* plant disease known as ‘‘jarrah dieback’’ overlap with underlying flora and vegetation values and are covered in other management plans and work procedures. Mine plans and soil movement plans not only consider bauxite ore grades and haul distances but also require input from these surveys.

This section presents the findings of the following:

- Past surveys for flora and vegetation
- Conservation significant flora and communities occurrence
- Rehabilitation studies

2.4.1.1 Summary of baseline surveys undertaken

Table 2-5 outlines the flora and vegetation studies that have been undertaken across the Huntly and Willowdale mine regions.

Results from each survey undertaken in baseline studies have enabled a delineation of key flora and vegetation values that relate to the following:

- Occurrence of conservation significant flora species
- Occurrence of restricted or poorly represented communities
- Vegetation Mapping (initially at site-vegetation type level and more recently vegetation complexes)

Table 2-5: Key Flora and Vegetation studies and research

Year	Author	Project / Study region	Summary of methods / results
1983, 1992, 1993	E.M. Mattiske & Associates	Jarrahdale, Chandler and Kingsbury Drive, Cobiac	Baseline Flora and Vegetation and Monitoring studies. Baseline studies based on detailed surveys on 120m x 120m grid systems as a minimum to align with drilling programs. Studies highlighted flora and site-vegetation types in respective areas. Site-vegetation types were based on earlier work of Havel (1975a, 1975b) for the northern Jarrah Forest. Studies included targeted flora searches with an emphasis on novel species, range extensions and threatened and priority species.
1985, 1988, 1991, 1992, 1993	E.M. Mattiske & Associates	Del Park, Bates, Jones, Huntly	Baseline Flora and Vegetation and Monitoring studies. Baseline studies based on detailed surveys on 120m x 120m grid systems as a minimum to align with drilling programs. Studies highlighted flora and site-vegetation types in respective areas. Site-vegetation types were based on earlier work of Havel (1975a, 1975b) for the northern Jarrah Forest. Studies included targeted flora searches with an emphasis on novel species, range extensions and threatened and priority species.
1994, 2009, 2012, 2019, 2021, 2022	Mattiske Consulting	Huntly, O’Neill, Myara,	Baseline Flora and Vegetation and Monitoring studies. Baseline studies based on desktop studies and detailed surveys on 120m x

Year	Author	Project / Study region	Summary of methods / results
		Myara North	120m grid systems as a minimum to align with drilling programs and representative permanent plots. Studies highlighted flora and site-vegetation types in respective areas. Site-vegetation types were based on earlier work of Havel (1975a, 1975b) for the northern Jarrah Forest. Post 1998, references to Mattiske and Havel vegetation complexes were also assessed in the regional context for vegetation representation in managed forest and conservation areas. Studies included targeted flora searches with an emphasis on novel species, range extensions and threatened and priority species
1993, 1994	E.M. Mattiske & Associates	Willowdale	Baseline Flora and Vegetation and Monitoring studies. Baseline studies based on detailed surveys on 120m x 120m grid systems as a minimum to align with drilling programs. Studies highlighted flora and site-vegetation types in respective areas. Site-vegetation types were based on earlier work of Havel (1975a, 1975b) for the northern Jarrah Forest.
1994, 1996, 1997, 2001, 2011, 2012, 2015, 2018, 2019, 2020, 2021, 2022	Mattiske Consulting	Willowdale, Keats, Larego, Vaquita, Holyoake	Baseline Flora and Vegetation and Monitoring studies. Baseline studies based on desktop studies and detailed surveys on 120m x 120m grid systems as a minimum to align with drilling programs and representative permanent plots. Studies highlighted flora and site-vegetation types in respective areas. Site-vegetation types were based on earlier work of Havel (1975a, 1975b) for the northern Jarrah Forest. Post 1998, references to Mattiske and Havel vegetation complexes were also assessed in the regional context for vegetation representation in managed forest and conservation areas. Studies included targeted flora searches with an emphasis on novel species, range extensions and threatened and priority species.
2005 to 2014, 2016 to 2021	Mattiske Consulting	Huntly, Myara and Willowdale	Assessment of rehabilitation areas at 9 months and 15 months (2005 to 2014). Assisting in data collection (2016 to 2021). Alcoa assisting in monitoring permanent plots as requested in spring months.
1988 to 1994 and 1996 to 2006	E.M. Mattiske & Associates, Mattiske Consulting	Monitoring transects	Assessment of creeklines and valley systems near Urbrae, Cameron, Gordon and Jayrup.

2.4.1.2 Significant Flora Species

The conservation significant species, current listing and potential occurrence within the operational areas is detailed in Appendix 2. Species that are known from only the Swan Coastal Plain and the Western Australian Wheatbelt and are therefore considered to have a very low probability of occurring in the operational areas of the Huntly and Willowdale mines have been excluded.

2.4.1.3 Significant Vegetation

The following Threatened and Priority Ecological Communities have been summarised previously as potentially being within or near the operational areas:

- Based on the database searches, there are four threatened ecological communities (TECs) listed at Commonwealth level pursuant to sections 181 and 182 of the EPBC Act and listed by the DCCEEW (2022a) or at State level pursuant to Part 2 of the BC Act and as listed by DBCA (2022c) with the potential to occur near or within the Alcoa operations. Currently, none of the above mentioned TECs would occur in the mining operational areas on the Darling Ranges. The threatened ecological communities are restricted to the Swan Coastal Plain and as such do not extend into the Jarrah Forest area on the Darling Range associated with the Darling Plateau.
- There is one botanical PEC, listed at State level (Granite Communities of the northern Jarrah Forest), which has been designated within the survey area in some sections of the operational areas. There is a potential that the site-vegetation types associated with granite outcrops (site-vegetation types G and R as defined by Mattiske utilising the definitions of Havel (1975a and 1975b) will have affinities with the PEC. Clarification of the latter affinities necessitated comparisons with the granite areas studied by Markey (1997) on the northern Darling Scarp and the eastern fringes of the northern Jarrah Forest. In this context there are some species that reflect the presence of exposed or shallow granite outcrops; however, these species tend to occur on wider areas of granites and the differentiation on whether all granite areas in the southwest should be aligned is open to interpretation.

2.4.1.4 Introduced or Weed Species

Introduced species are categorised according to the threats that they pose to the environmental values addressed by this FVMP.

Weed species, location and abundance are recorded during pre-clearing surveys and assessed against the Federal Weeds of National Significance (WONS) listing (DCCEEW, 2022c), the State declared weeds list (DPIRD 2022), the environmental weeds as listed by the DBCA (2022b) and any new weeds that have not been recorded in the southwest forests. Control and management measures are listed in the respective references. In addition, many species may be missing from the Swan Region listings as information for some species may not have been assessed (e.g., U - Unknown category or not listed at all in this publication).

Species that might occur (based on Florabase (DBCA 2022a) or that have been recorded in the three sub operational areas are detailed in Appendix 3. Some introduced or weed species are introduced by others either through dumping garden waste or other activities in the State Forest which are beyond the control of Alcoa. Other species listed in Table 9 occur as garden escapes from plantings on small private properties. Many species are restricted to disturbed areas such as road verges, cleared agricultural and small land holdings and as such rarely occur in forest areas or within rehabilitation areas.

2.4.1.5 Dieback and other Forest Diseases

Alcoa has established protocol for delineating and managing fungal diseases such as the dieback associated with *Phytophthora cinnamomi* within and near operational areas Koch (2007). Dieback is an exotic plant disease caused by the microscopic organism *Phytophthora cinnamomic*. About 40% of the indigenous plant species in the jarrah forest are susceptible to this pathogen. Integration of an intensive dieback management program within all mining processes (development, mining, and rehabilitation) is part of the environmental management system for WA mining operations. All forest areas are mapped for dieback in advance of any exploration activities. A dieback interpretation recheck is undertaken for any area in which an operation is planned where more than 12 months have elapsed since the last interpretation. This information is used when planning access and mining activities.

Alcoa engage a qualified supplier to perform Phytophthora Dieback Mapping services (and other forest disease) in accordance with the DBCA guidelines and standards as per the DBCA Dieback Interpreters Manual. The Supplier as the industry expert has been requested to inform Alcoa if they become aware of other forest diseases that they observe in the forest or become aware could be entering the forest, through industry knowledge/connections.

2.4.1.6 Fire

The Southwest forests have been subject to fire by indigenous people prior to European settlement for cultural reasons. Controlled burning activities are undertaken by DBCA, and as such the role of burning in Alcoa operations are undertaken in consultation with district and regional DBCA offices. Fire activities are undertaken in pre-clearing areas in consultation with DBCA and during initial clearing activities to assist in preparing operational areas for mining. The plants of the southwest forest region have mechanisms to be resilient to fire and recent efforts have been undertaken to manage the forests to minimize risks associated with uncontrolled intense wildfires which is unfavourable to some plant species.

Fire is generally excluded in the initial rehabilitation phases, partly as the fuel load is not sufficient to carry the fires but mainly to protect the establishment and growth of forest trees in the overstorey and to develop biodiversity values in the rehabilitation areas. Older rehabilitation areas are subject to fire when the initial risk to biodiversity values is reduced.

2.4.1.7 Dust

Fugitive dust emissions from vegetation clearing, disturbed areas, mine pit excavation, crushing and road use have been identified as a potential indirect impact to vegetation. To date, there has been limited monitoring undertaken for dust deposition and it is unknown at what rates cause adverse impact to native flora and vegetation.

2.4.1.8 Rehabilitation

2.4.1.8.1 Historical Rehabilitation Practices

Alcoa commenced mining in 1962, and since then, Alcoa has rehabilitated 21,500 hectares. The rehabilitation areas have seen significant changes in rehabilitation practices. The early 1966-1970 rehabilitation consists of plantations of either *Pinus* or *Eucalyptus* species native to the eastern states of Australia, planted after very limited site preparation. These species were chosen for their resistance to *Phytophthora cinnamomi*. The 1971-1977 rehabilitation, again consisting of plantations, included more surface treatments such as landscaping and ripping. The 1978-1987 rehabilitation has a broader range of floristic characteristics established by seeding understorey species but with few Eucalyptus species native to the Darling Range. This rehabilitation aimed at establishing a functioning and self-sustaining eucalypt forest. The post-1988 rehabilitation has been undertaken by direct seeding indigenous species, with jarrah as the dominant Eucalyptus species. Rehabilitation is now aimed at restoring a self-sustaining jarrah forest ecosystem.

2.4.1.8.2 Research

Alcoa has undertaken extensive rehabilitation assessments over many decades since commencing operations in 1963. Key reviews by Koch (2007) and Koch and Hobbs (2007) have provided succinct summaries of the progress on rehabilitation activities on Alcoa leases.

Since the early 1980s, Alcoa has had an extensive research program into the establishment, sustainability and management of ecosystems developing on rehabilitated bauxite mines. Alcoa's Environmental Research Group, in collaboration with universities, CSIRO and Government departments has developed a comprehensive portfolio of projects examining many facets of ecosystem recovery in rehabilitated areas. Many long-term studies looking at:

- Vegetation establishment, survival and succession.
- Vegetation productivity, sustained growth and structure development.
- Fauna colonisation and habitat development.
- Ecosystem processes such as soil development and nutrient cycling, and the recolonisation of specific fauna groups such as ants, spiders and termites that are involved in these processes.
- Microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration.
- Effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development.
- Resilience of vegetation to disease, insect attack, drought and fire.
- Vegetation water use and effects on ground water levels and catchment yields.

The completion criteria are supported in many instances by these research findings.

Table 2-6: Key Rehabilitation studies and research

Year	Author	Project / Study region	Summary of methods / results
2007	Koch and Hobbs	Revegetation	This research summary highlighted key research studies that have assisted in optimising rehabilitation practices in the Jarrah Forest on bauxite mining area.

Year	Author	Project / Study region	Summary of methods / results
			This highlighted relationships between site conditions, plant-soil-water interactions and the development of key ecosystem attributes such as: Vegetation Structure (Grant et al. 1997, 1998; Norman et al. 2006; Grant et al. 2007a). The structure of restored sites is initially different from that in unmined forest; however, over time through vigorous growth and then hazard burning or silvicultural burning becomes more similar. By returning a wider range of plant species with different growth forms the multi-layered structure of the Jarrah Forest is restored. This shift over time from initial trials to more complex treatments assisted in optimization of regrowth on these areas. Measurements on plant species richness, diversity, evenness, and similarity (Nichols & Michaelsen 1986; Norman et al. 2006 and Koch 2007a) along with fauna usage of the areas over time (Nichols and Grant 2007) assisted in the development of diversity on the rehabilitation areas. Conservation goals have been assisted by using local provenance species and indigenous species in seeding and planting to facilitate species and genetic integrity of the communities (Krauss and Koch, Koch 2007a). Ecological processes have been facilitated by research on ripping of the soil profiles on the mined areas with deeper ripping favouring the restoration of ecological processes (Croton and Ainsworth 2007; Szota et al. 2007). The latter was reinforced by studies undertaken by Grant (2006) which reflected soil compaction was a key limiting factor to ecological processes. Studies over the last 20 or more years have stressed the significance of returning topsoil, fertiliser, soil handling procedures and nitrogen fixing legumes in these processes. Sustainability measures have included a wide range of parameters including sustained tree and understorey growth and diversity, litter development, flowering and fruiting of plant species and development of soil components and fauna species (both invertebrate and vertebrate).
2007	Koch and Hobbs	Synthesis: Is Alcoa Successfully Restoring a Jarrah Forest Ecosystem?	Some gaps in development have also been noted, such as the development of tree hollows and older trees (Whitford 2002). The latter is not unexpected as some older forest trees exceed 200 - 400 years in the south-west forests. In defining the limitations, it has also been recognised that some factors such as drying climate or diseases introduced by other activities beyond the control of Alcoa may influence the rehabilitation and the forest areas in the longer term. Some imbalances in the rehabilitation areas when compared with the unmined areas of the re-sprouter species (Koch 2007a).
2007	Grant et al. 2007a Koch and Samsa 2007	Tree Production	Current data suggests that the Jarrah trees growing on the rehabilitation areas reflect all the same silvicultural features, including growth response to thinning (Grant et al. 2007) as equivalent regrowth trees in the unmined areas (Koch and Samsa 2007)
2007	Koch and Hobbs	Feral and Introduced	Alcoa has supported research into the control of diseases and feral animals (e.g. Operation Foxglove for foxes, Nichols and

Year	Author	Project / Study region	Summary of methods / results
		species and Diseases	Grant 2007), weed control and disease management to minimize the negative impacts of these components on their operations.

2.4.2 Key assumptions and uncertainties

The key assumptions and uncertainties are considered to include:

- the extent to which climatic factors outside of Alcoa's control will affect the spread of dust, weeds and fire into the operational areas.
- the level of dust deposition that has the potential to indirectly impact vegetation and flora within the operational areas.
- the extent to which climatic factors (i.e. climate change) outside of Alcoa's control will impact on the health and extent of populations of significant flora and vegetation values.
- the extent to which local hydrological changes to water flows will directly or indirectly impact on the health and extent of populations of flora and vegetation values.
- The extent of conservation significant flora and vegetation within the operational areas, until pre-clearance targeted surveys are completed.
- The extent that seasonal conditions influence the ability to locate some significant flora species.

2.4.3 Objective-based EMP – risk-based approach.

The FVMP has been developed using a risk-based approach that outlines management provisions to minimise risks. Appendix 4 presents a risk assessment of the potential impacts to conservation significant flora and vegetation values identified within the Huntly and Willowdale mines.

As presented in Appendix 4, the risk assessment indicated the following Moderate and High risks, in which mitigations/actions need to be applied. There are no Extreme risks identified for the Huntly and Willowdale mines.

High Risks:

- Clearing activities
- Fragmentation
- Restoration of vegetation

Moderate Risks:

- Dust deposition
- Alteration of surface water flows
- Introduction and spread of weeds.
- Altered fire regimes.
- Increased weeds
- Climate change induced habitat change

2.4.4 Rationale for choice of interim indicators and/or interim management actions

The mitigation hierarchy of avoidance, minimise and rehabilitate has been adopted to manage impacts. Management based provisions have been selected to reflect the potential changes in mine plans and potential impacts. Given clearing occurs on ongoing basis, the potential for environmental changes, particularly from external factors (other activities, climate change, the Forest Management Plan, etc), requires an adaptive FVMP.

2.4.4.1 Focus on Avoidance

Direct impacts of the conservation significant flora and vegetation values will be avoided where possible. The internal vegetation clearing procedures will be utilised to control clearing within the operational areas.

Any threatened key flora and vegetation values will be delineated by an appropriate means to prevent unauthorised access. Access will be limited to foot access only or vehicle access only to existing cleared tracks and controlled by a procedure and permitting process. This will aim to ensure the area is only accessed for monitoring or rehabilitation activities to meet the requirement of this FVMP. All personnel will be made aware of the requirement to avoid these areas supporting significant flora and vegetation values through the site induction process. Such an approach will assist in aligning with the need to protect threatened flora with a 50 m buffer implemented. Where the latter is not feasible, as a result of previous established disturbances or for critical infrastructure and operational activities, then these areas will be addressed through consultation and necessary approvals with regulators prior to clearing activities.

2.4.4.2 Minimising Potential Impacts

While the objective to avoid direct impacts to the significant flora and vegetation values is readily achievable, the potential for factors that may lead to potential adverse indirect impacts also needs to be addressed. For this reason, potential indirect impacts such as dust, disease, fire and weeds need to be minimised in order to meet the environmental outcomes.

Indirect impacts will be minimised by using best practice risk management to suppress dust, control invasive plant species, and prevent the spread and intensification of vegetation pathogens, including dieback.

2.4.4.3 Remediation/Rehabilitation actions where impacts cannot be avoided

Where direct impacts cannot be avoided, every effort will be undertaken to remediate these areas through rehabilitation activities. This shall include consultation with EPA and DBCA to determine appropriate strategies and actions.

2.4.4.4 Integration of Research into Completion and Closure

The findings of ongoing research programs are integrated into rehabilitation practices to ensure best practice.

3 EMP Components

This section of the FVMP identifies the provisions Alcoa will implement to ensure the defined environmental outcomes and objectives are met during the implementation of this FVMP. Monitoring has been designed to inform, through the environmental criteria and management targets if the corresponding environmental outcomes and objectives are being achieved.

Objectives, management based interim provisions and monitoring provisions are detailed in Table 3-1 and Table 3-2.

This FVMP will be updated to align with the adaptive management approach (refer to Section 4)

Table 3-1: Management Objectives and Targets

Region specific flora and vegetation values	Impacts	Environmental management objectives	Management Targets
• Threatened Flora under BC Act and EPBC Act • Priority Flora • Significant Species (novel species, range extensions and restricted occurrences) • Vegetation types which support conservation significant flora species • Threatened ecological communities. • Priority ecological communities • State Forest • Old growth forest	• Direct loss of conservation significant vegetation, communities and flora individuals • Fragmentation or isolation of conservation significant populations or occurrences • Reduction in critical habitat	Minimise direct loss of conservation significant flora, vegetation and communities from mining and construction activities. Minimise the fragmentation of vegetation and landforms that support conservation significant flora and vegetation. Upon rehabilitation completion, establish a self-sustaining jarrah forest ecosystem	No significant impacts to conservation significant flora populations, vegetation or communities as a result of clearing activities (including fragmentation)
			No clearing of threatened flora individuals or communities without regulatory consultation and appropriate approvals
			Rehabilitated areas meet relevant completion criteria
	• Decline in health and/or change in flora and vegetation composition. • Introduction or promotion of weeds and/or disease, and temporary impacts such as fire • Altered hydrology, including alteration of surface water flow and groundwater level	Minimise indirect impacts on flora, vegetation and communities outside the approved clearing boundaries.	No reduction in quality of conservation significant flora or communities resulting from dust deposition
			No reduction in quality of conservation significant flora or communities resulting from introduction or spread of weeds, Phytophthora dieback or other forest diseases or fire
			No significant impact to surface water values as a result of hydrological regime changes from mining activities
			No significant impact to groundwater values as a result of hydrogeological regime changes from mining activities

Table 3-2: Management Objectives and Commitments

EPA factor/s and objective/s: To protect flora and vegetation so that biological diversity and ecological integrity are maintained. **Objective/s:** Minimise direct loss of conservation significant flora from mining and construction activities. **Key environmental values:** Threatened Flora under BC Act and EPBC Act, Priority Flora, Significant Species, Vegetation types which support conservation significant flora species, Threatened and Priority ecological communities. **Key impacts and risks:** Direct loss of conservation significant vegetation, communities and flora individuals				
Objective-based				
Management targets	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
Commitment 3: Alcoa will plan and manage its mining operations to minimise disturbance to biologically diverse areas fringing major rock outcrops and stream zones. Appropriate buffers will be maintained between these areas and mine pit boundaries. Stream crossings will be constructed in a manner which facilitates their removal and rehabilitation after use, unless required for ongoing forest management or other purposes agreed with the State's Mining and Management Program Liaison Group (MMPLG). **Commitment 9:** Alcoa will implement a comprehensive dieback management program designed specifically for its mine operations in the jarrah forest. This will include rehabilitation of dieback-affected areas adjacent to its mine operating areas, in accordance with procedures agreed with State agencies, and irrespective of the cause of introduction of the disease.				

1. No significant impacts to conservation significant flora populations, vegetation or communities as a result of clearing activities
 	
No clearing of threatened flora individuals or communities without regulatory consultation and appropriate approvals
	• Conduct baseline flora surveys as per Table 3-3
	• Conduct pre-clearance surveys in suitable habitat as determined by baseline flora surveys as per Table 3-3
	• Implement Mining Avoidance Zones for:
	  ○ Threatened species (unless regulatory consultation and appropriate approvals obtained)
	  ○ DBCA Old growth forest
	  ○ National Park, formal conservation reserves
	• Implement Mining Exclusion Zones for:
	  ○ Rock outcrops greater than one hectare and biologically diverse areas fringing granite outcrops.
	  ○ Stream Zone vegetation
	  ○ Threatened species (unless regulatory consultation and appropriate approvals obtained)
	  ○ Conservation significant flora (as far as practicable)
	  ○ DBCA Old growth forest
		• Indicator: Conservation significant flora and vegetation presence
		• Method: Pre-clearance surveys as per Table 12
		• Indicator: Clearing completed (clearing register)
		• Method: Annual clearing review
			• As required	• Outcomes of pre-clearance surveys to be reported in AER.
				• If management target is exceeded (i.e significant impact or clearing of threatened flora), reporting as per internal Incident Reporting and Investigation Procedure

EPA factor/s and objective/s: To protect flora and vegetation so that biological diversity and ecological integrity are maintained. **Objective/s:** Minimise direct loss of conservation significant flora from mining and construction activities. **Key environmental values:** Threatened Flora under BC Act and EPBC Act, Priority Flora, Significant Species, Vegetation types which support conservation significant flora species, Threatened and Priority ecological communities. **Key impacts and risks:** Direct loss of conservation significant vegetation, communities and flora individuals				
Objective-based				
Management targets	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
	○ National Park, formal conservation reserves • Mining Avoidance and Exclusion Zones will be demarcated in construction spatial data to guide construction personnel and included on construction maps. • Minimise infrastructure clearing of stream zone vegetation and rock outcrops. • Minimise clearing of mature growth forest. • Clearing activities undertaken as per Vegetation Management Plan (CDS 2053-5517) • Spatial data of conservation significant flora and communities retained and review as Surface Disturbance Procedure to ensure clearing impacts are not significant. • If clearing of threatened species is required, then management options will be developed in consultation with DBCA and DCCEW with appropriate approval obtained under the BC Act and EPBC Act. • Reduce as far as practicable the creation of vegetation islands <10ha in size. • Reduce as far as practicable the creation of vegetation with single connection to larger remnants (peninsulas) • Design and construct haul road creek crossings, perpendicular to the creek flow to minimise the area of habitat impacted.			
2. Rehabilitated areas meet relevant completion criteria	• Integrate rehabilitation into mining planning and operational activities. • Undertake rehabilitation activities in a timely and committed way to enable maximisation of progress on rehabilitation areas. • Undertake adaptive management based on research to encourage the return of native species and a self-sustaining forest ecosystem. • Maintain monitoring and assessment to enable rapid responses to invasive weeds and erosion within local areas within the rehabilitation areas.	• Indicator: Vegetation establishment & resilience of vegetation • Method: Rehabilitation monitoring as per Vegetation Management Plan (CDS 2053-5517)	• Rehabilitation monitoring at 9 months and 15 months following rehabilitation completion and ongoing assessment of permanent plots	• Annual reporting and comprehensive three yearly reporting. • If management target is exceeded,

EPA factor/s and objective/s: To protect flora and vegetation so that biological diversity and ecological integrity are maintained. **Objective/s:** Minimise direct loss of conservation significant flora from mining and construction activities. **Key environmental values:** Threatened Flora under BC Act and EPBC Act, Priority Flora, Significant Species, Vegetation types which support conservation significant flora species, Threatened and Priority ecological communities. **Key impacts and risks:** Direct loss of conservation significant vegetation, communities and flora individuals				
Objective-based				
Management targets	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
	• Maximise the use of all materials used in clearing and rehabilitation practices to minimize waste and utilise resources as available (including overburden/topsoil, native seeds, clearing debris, timber logs and waste) • Maintain regular monitoring program at 9 months, 15 months, and ongoing permanent plots to substantiate progress and respond to any issues that arise that will inform adaptive management choices to continually improve outcomes. • Conduct ongoing benchmarking against best practice options.	• Indicator: Rehabilitation completed (clearing register) • Method: Annual clearing/rehabilitation review	in both rehabilitation and control areas. • Annual review of Clearing Register	reporting as per internal Incident Reporting and Investigation Procedure
3. No reduction in quality of conservation significant flora or communities resulting from dust deposition	• dust suppression for conveyor belts (through utilisation of covers), haul roads and other key operational areas • maximise efficiency of loads when transporting ore or concentrate (including haul trucks and conveyers) • use dust suppressants on exposed areas where possible. • minimise open area footprint and rehabilitate or cover (using vegetation, rock, water and/or dust suppressant) exposed areas as soon as practicable. • Investigate alternatives for the wood waste burning of clearing residues to reduce the particulate emissions in the local airshed. • Induction packages – the workforce will be made aware of dust generation and control measures. • Routine housekeeping practices around central facilities and workshops will be implemented to reduce dust generation. • Optimising blast charge sizing and spaces to avoid unnecessary energy releases which has the potential to generate dust. • The location of haul roads, conveyors, mine pits and other infrastructure gives consideration to separation distance from receptors to reduce air quality impacts.	• Indicator: Dust deposition rate in association with decline in vegetation condition • Method: Dust monitoring program	• Annual	• Annual reporting. • Vegetation health monitoring as required if evidence of rapid decline near operational areas.

EPA factor/s and objective/s: To protect flora and vegetation so that biological diversity and ecological integrity are maintained. **Objective/s:** Minimise direct loss of conservation significant flora from mining and construction activities. **Key environmental values:** Threatened Flora under BC Act and EPBC Act, Priority Flora, Significant Species, Vegetation types which support conservation significant flora species, Threatened and Priority ecological communities. **Key impacts and risks:** Direct loss of conservation significant vegetation, communities and flora individuals				
Objective-based				
Management targets	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
4. No reduction in quality of conservation significant flora or communities resulting from introduction or spread of weeds, Phytophthora dieback or other forest diseases or fire	• Inspection of construction and operational vehicles and equipment for soil and vegetative material prior to entry to undisturbed areas. • implementation of a vehicle hygiene procedure, dieback management procedure and weed control. • Construction and operational vehicle and equipment movements limited to designated roads, access tracks and cleared areas. • Conceptual Clearing Area will be surveyed for Weeds of National Significance (WoNS), Declared and invasive weeds prior to clearing as part of Targeted surveys. • Weed monitoring will occur periodically, particularly in high-risk areas (stream zones and existing roads) and recorded weed infestations, so that any infestations that establish can be eradicated before the plants can flower and set seed • All identified WoNS and environmental weeds treated according to the weed control management outlined by Weeds Australia with the aim of controlling off-site movement. • Phytophthora cinnamomi (dieback) and other forest diseases controls including signage, clean down points, vehicle hygiene shall be implemented. • Demarcation of Dieback infested, uninfested and uninterpretable areas in construction and operational drawings and in the field using pegs and signage. • Topsoil, overburden and vegetative material (e.g. coarse woody debris) from uninterpretable or infested areas not to be moved to uninfested areas. • Containment of stormwater runoff from identified Dieback infested areas to prevent discharge into uninfested areas. • Rehabilitation plants will only be sourced from nursery suppliers with appropriate weed and dieback control management. • Revalidation of Dieback assessment every 12 months where construction or operations planned for greater than a 12 month duration.	• Indicator: Weed species presence • Method: Pre-clearance surveys as per Table 12, Rehabilitation monitoring as per Vegetation Management Plan (CDS 2053-5517) and bi-annual weed inspections • Indicator: Dieback status • Method: Pre-clearance surveys as per Table 12	• As required	• Annual reporting. • Incident reports. • Dieback mapping reports

EPA factor/s and objective/s: To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Objective/s: Minimise direct loss of conservation significant flora from mining and construction activities.

Key environmental values: Threatened Flora under BC Act and EPBC Act, Priority Flora, Significant Species, Vegetation types which support conservation significant flora species, Threatened and Priority ecological communities.

Key impacts and risks: Direct loss of conservation significant vegetation, communities and flora individuals

Objective-based				
Management targets	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
5. No significant impact to surface water values as a result of hydrological regime changes from mining activities	Refer to Water Resources Management Plan			
6. No significant impact to groundwater values as a result of hydrogeological regime changes from mining activities	Refer to Water Resources Management Plan			

3.1 Implementation

The implementation of the FVMP will be assisted through an Environmental Management System that will incorporate systems, processes, procedures, and work instructions relating to the management, monitoring and reporting components of the FVMP.

3.2 Monitoring

Monitoring includes pre-clearing surveys to identify conservation significant flora and vegetation to minimise impact. Details on pre-clearing surveys required are detailed in Table 3-3.

Ongoing monitoring is undertaken to confirm adequacy of management actions and compliance to Management Targets. A summary of the monitoring commitments is included in Table 3-4. The monitoring program will involve monitoring plants and vegetation, dieback and diseases, vegetation condition, dust deposition and weed monitoring in order to:

- determine if there are any changes occurring to flora and vegetation condition and health in the operational areas.
- assess whether any changes in flora and vegetation are due to the Project or external/natural factors.
- provide a methodology for ongoing monitoring to enable time-based comparisons.

This will be achieved as the program has been designed to be:

- extensive – sites within representative vegetation communities both within the impact and non-impact control sites.
- balanced – replicate sites within potential impact areas, and areas outside of the Proposals influence to enable statistical analyses (for example but not limited to, ANOVA, MANOVA).
- repeatedly measurable, reliable and adaptable; allowing monitoring to be intensified or decreased as required based on measurements made.

Table 3-3: Pre-clearing Survey Summary

Survey Type	Application	Methodology	Timing	Frequency	Flora Management Response Actions
Baseline Survey – Desktop assessment	Conceptual Clearing Area and a 500m buffer	• Search of State databases (currently NatureMap) held and managed by DBCA with a minimum of 10 km and 20 km radius from central point of Conceptual Clearing Area for conservation significant species and ecological communities. • Search of Federal databases held and managed by DCCEEW with a minimum of 10 km and 20 km radius from central point of Conceptual Clearing Area. This includes the Protected Matters Search Tool (PMST) which assists in highlighted matters of National Environmental Significance (MNES), Threatened Species and Ecological Communities and Weeds of National Significance (WoNS). • Review all previous Alcoa flora and vegetation data. • All data to be reviewed for currency of taxonomic nomenclature with the Florabase (DBCA 1998-) data set. • The regional dataset based on vegetation complexes (Mattiske and Havel 1998) are reviewed for potential values in the survey areas. • Local and regional representation of the respective Threatened and Priority flora species and Ecological Communities is then assessed in the local, regional and national context; with an emphasis on concentrating effort in areas where species likely to occur.	Prior to development of Proposed Clearing Area	As required	Development of mining exclusion zones, where possible, for the following: • Recent records of Threatened Ecological Communities and flora individuals if likely to occur in the areas. • Rock outcrops greater than one hectare and surrounding vegetation within 10m buffer. • Old growth forest

Survey Type	Application	Methodology	Timing	Frequency	Flora Management Response Actions
Baseline – Field Survey (Flora and Vegetation)	Conceptual Clearing Area and a 500m buffer	Regular recordings on a grid system of 120m x 120m as a minimum and as required increase to cover local changes (particularly near outcrops and valley floors); e.g., a more intensive sampling and targeted searches in areas that are likely to support significant species and communities. Permanent quadrats in representative site-vegetation types including a minimum of three representative plots in each site-vegetation type to align with EPA (2016a). In all surveys, effort should be directed to clear tracking of survey effort, seasonal coverage of flora and detailed data collection on significant native species (including population numbers and location) and introduced plant species. Targeted flora searches should be defined and based on previous desktop studies on species and site preferences (e.g., species that may occur near outcrops, creek-lines and in swamps). Regular recording of degree of logging, number of stumps, potential old growth forests (based on DPAW methodology 2017 - Department of Parks and Wildlife 2017, *Procedures for the assessment, identification and demarcation of old-growth forest.* Prepared Department of Parks and Wildlife, March 2017), ground-water dependent ecosystems and condition of vegetation.	Prior to development of Proposed Clearing Area.	As required (Surveys valid for five years)	Development of mining exclusion zones for the following: • Confirmed Threatened Ecological Communities and flora individuals, if avoidance is possible. • Rock outcrops greater than one hectare • Old growth forest If avoidance of Threatened species or communities is not possible, regulatory consultation and appropriate approvals will be obtained
Pre-clearance Survey (Threatened flora & declared weeds)	Proposed Clearing Area	As per EPA Guidance, targeted surveys will be undertaken where a high likelihood of conservation significant species is expected (i.e., likely habitat as per Table 8): • 10 or 20 m traverses in a grid pattern should be considered to identify species presence or absence. If species are found then botanist will modify the intensity of the survey until the impacted population is delineated. • Other conservation significant flora species will be recorded when identified. A separate research program will investigate Priority species occurrences and assess impacts.	Prior to finalisation of Proposed Clearing Area. Timing determined by optimal identification of targeted species.	As required (surveys valid for five years)	

Survey Type	Application	Methodology	Timing	Frequency	Flora Management Response Actions
		• Record any WoNS, declared and invasive weeds to be managed refer to Table 9 Summary of Key Introduced or Weed Species			

Pre-clearance Survey (Dieback and other forest diseases)	Exploration drilling area
	
	Proposed Clearing Area
		• Dieback mapping will be undertaken by a suitably qualified interpreter.
		• The dieback mapping categories are grouped to create three operating categories:
		  ○ Dieback
		  ○ Dieback Free
		  ○ Uncertain
		• The hygiene mapping categories are ranked from lowest (secure Dieback Free) to highest (dieback) likelihood of *P. cinnamomi* infections being present.
		• Consistent with DBCA standards dieback interpretation is valid for 12 months. Interpretation older than 12 months is re-checked before operations commence in the area.
		• Only DBCA accredited interpreters will undertake mapping
		• Current dieback mapping methodology is also suitable for identifying other soil-borne forest diseases.
		• Mapping consists of sampling soil and tissue and analysis for *Phytophthora cinnamomi's* pathogen presence, in conjunction with field observations
			Prior to exploration drilling and clearing activities.	12 months prior to clearing	• Dieback hygiene controls to be implemented, as per Alcoa/DBCA Working Arrangements.

Table 3-4: Summary of monitoring programs

Management Target	Monitoring	Details	Timing	Frequency
• No significant impacts to conservation significant flora populations, vegetation or communities as a result of clearing activities (including fragmentation) • No clearing of threatened flora individuals or communities without regulatory consultation and appropriate approvals • No reduction in quality of conservation significant flora or communities resulting from dust deposition • Decline in rehabilitation health due to drying climate should be equivalent to that observed in unmined forests.	• Vegetation Health monitoring • Vegetation dust monitoring program	• Observations of plant health (e.g. initially vegetative cover from aerial imagery over site and in adjacent areas of forest). Following the development of a strong dataset over this period, the monitoring methodology, frequency and monitoring sites will be reviewed. • Control sites will be established. • An indicator of change is considered to be Statistically significant reduction in mean condition ratings (more than 20% difference for both qualitative and quantitative) of vegetation health in comparison to control sites • Dust deposition gauges in association with conservation significant flora and vegetation. Dust deposition rates will be measured regularly on any impacted vegetation	Autumn/Spring	Annual
• Rehabilitated areas meet relevant completion criteria • No reduction in quality of conservation significant flora or communities resulting from introduction or spread of weeds, Phytophthora dieback or other forest diseases or fire	• Rehabilitation monitoring	• Rehabilitation observations that align with the relevant completion criteria. Current completion criteria that are relevant to Flora and Vegetation are detailed in Table 6. • Permanent rehabilitation monitoring plots will be monitored periodically to observe the trajectory of vegetation re-establishment, and prior to handback to ensure that completion criteria are met.	• Autumn – 9 Month Monitoring • Spring – 15 Month Monitoring • Spring - Long Term Monitoring	• 9 months and 15 months following rehabilitation completion. • Sites reviewed against completion criteria at 12 years or more prior to handback.
• No significant impact to surface water values as a result of change in hydrological regime from mining activities • No significant impact to groundwater values as a result of change in hydrogeological regime from mining activities	• Vegetation health monitoring	• Vegetation health monitoring photos as per Surface Water Licence and Part V Licence (Wastewater discharge – Willowdale) • Unmanned aerial vehicle (UAV) to assess rehabilitated areas for erosion. Remedial action may be undertaken based on this monitoring.	Spring	• Annual Vegetation photos • 24 Months UAV review

4 Adaptive Management and Review of the EMP

Alcoa recognises the dynamic nature of ecosystems and supports adaptive management under this FVMP. Adaptive management involves:

- implementing mitigation measures
- monitoring and evaluation against management targets
- systematically adapting management and mitigation measures and monitoring to meet the environmental objectives.

Any changes to management practices will instigate a review and consideration of management actions. Assumptions and uncertainties will be evaluated against collected monitoring data on a recurrent basis in a process of continual improvement and establishing early response indicators/criteria. Examples of adaptive management throughout operations include:

- the introduction of a different / alternative monitoring initiative to better understand monitoring of the non-operational and impact areas
- outcomes of Alcoa's research program, which includes investigations into Priority flora species occurrence, distribution, and impacts
- changes to management actions and targets in response to monitoring data
- changes in species conservation ranking
- changes in technology.

Alcoa will update this FVMP as required to include any adaptive management updates based on information gathered from monitoring results.

4.1 Changes to an EMP

Based on result of the review process Alcoa will update and adjust the measures and strategies as per Table 4-1 below.

Table 4-1: Changes to an EMP

Complexity of changes			**Minor revisions** ☐ **Moderate revisions** ☐	**Major revisions** ☐
Number of Key Environmental Factors			**One** ☐ **2-3** ☐	**> 3** ☐
Date revision submitted to EPA: DD/MM/YYYY				
Proponent's operational requirement timeframe for approval of revision **Reason for Timeframe:**			**< One Month** ☐ **< Six Months** ☐ **> Six Months** ☐ **None** ☐	
Itemno.	**EMP section no.**	**EMP page no.**	**Summary of change**	**Reason for change**
1.				
2.				
3.				

5 Stakeholder Consultation

Stakeholder engagement with State Departments and Local Government Authorities commenced in the 1970's. Alcoa has developed and implemented an external stakeholder consultation strategy for ongoing social engagement and community investment.

The stakeholder consultation strategy has adopted the principles from the Ministerial Council on Mineral and Petroleum Resources (MCMPR) *Principles for Engagement with Communities and Stakeholders* (2005). This includes:

- open and effective communication:
- two–way communication
- clear, accurate and relevant information
- timeliness
- transparency, requiring a process for communication and feedback
- collaboration, working cooperatively to seek mutually beneficial outcomes
- inclusiveness, with the aim of recognising, understanding and involving stakeholders early and throughout the process
- integrity, with engagement undertaken in a manner that fosters mutual respect and trust.

The outcomes of the consultation strategy are recorded in the Stakeholder Consultation Register. Consultation to date has been comprised predominately of meetings and correspondence with a number of State and Federal Departments and Agencies, Local Government Authorities, Traditional Owners and non–government organisations and interest groups.

Alcoa is committed to ongoing stakeholder identification, communication, engagement and consultation through the planning and approval phase, and through to construction, operational and closure phases of the Project.

The key stakeholders in Flora and Vegetation values include:

- State government
- Federal government
- Local government
- Non–government organisations and interest groups.

A comprehensive list of key stakeholders is provided in Table 5-1.

Table 5-1: Key Stakeholders

Stakeholder Group	Stakeholder	Key Interests
State Government	Environmental Protection Authority (EPA)	• Administration of the *Environmental Protection Act 1986* (EP Act) • Part IV (EP Act) Environmental Impact Assessments (EIA).

Stakeholder Group	Stakeholder	Key Interests
	Department of Water and Environmental Regulation (DWER)	• Input into environmental scoping and assessments. • Compliance reporting
	Water Corporation	• Catchment Management
	Department of Mines, Industry Regulation and Safety (DMIRS)	• Administration of the *Mining Act 1978* (Mining Act) • Tenement conditions • Closure and rehabilitation • Safety.
	Department of Biodiversity, Conservation and Attractions (DBCA)	• Administration of the *Biodiversity Conservation Act 2016* (BC Act) • Flora, fauna and habitat conservation. • State Herbarium specialists • TEC/PEC specialists
	Department of Planning, Lands and Heritage (DPLH)	• Native title and indigenous requirements • Heritage sites.
	Department of Fire and Emergency Services (DFES)	• Emergency services • Fire breaks • Fire reduction.
	DWER - Water	• Water catchments
	Main Roads Western Australia (MRWA)	• Use of public roads.
Federal Government	Department of Climate Change, Energy, the Environment and Water (DCCEEW)	• Administration of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) • Referral and assessment of environmental impact assessments of matters of national environmental significance.
Local Government	Shires of Armadale, Serpentine-Jarrahdale, Murray, Harvey, Waroona, Kwinana and Bunbury	• Use of public roads and infrastructure.
Non–government organisations and interest groups	Local landholders; Local NRM group (Peel-Harvey) Institute of Foresters; Local Indigenous Groups Universities and Researchers; Dieback Working Groups; Conservation Council of Western Australia; Wilderness Society;	• Protection of conservation significant species • Forest management • Research groups • Potential interest in baseline flora and fauna survey data.

Stakeholder Group	Stakeholder	Key Interests
	WA Forest Alliance.	

References

Conservation Codes (2019) Conservation codes for Western Australia Flora and Fauna. Department of Biodiversity and Attractions. Last updated 3 January 2019.

Churchill, D. M. (1961). The Tertiary and Quarternary vegetation and climate in relation to the living flora in south Western Australia. Ph. D. Thesis, UWA.

Churchill, D. M. (1968). The distribution and prehistory of *Eucalyptus diversicolor* F. Muell, *E. marginata* Donn Ex Sm., and *E. calophylla* R. Br. in relation to rainfall. *Aust. J. Bot.* 16, 125 – 151.

Churchward, H.M and W.M. McArthur (1980). *Landforms and Soils of the Darling System, Western Australia.* In: Department of Conservation and Environment (1980) Atlas of Natural Resources Darling System, Western Australia. Published by the Department of Conservation and Environment, Perth, 1980.

Colquhoun, I. J., and N. L. Kerp. 2007. Minimizing the spread of a soil-borne plant pathogen during a large-scale mining operation. Restoration Ecology Supplement 15:S85–S93. Conservation Commission (2003). Forest Management Plan 2004-2013. Data extracted for representation of Vegetation Complexes from former Department of Conservation and Land Management.

Conservation Commission (2013). Forest Management Plan 2014-2023. Plan prepared by the Western Australian Conservation Commission, Perth.

Department of Biodiversity, Conservation and Attractions (2022a). FloraBase – the Western Australian Flora, Department of Parks and Wildlife. Available from: https://florabase.dpaw.wa.gov.au.

Department of Biodiversity, Conservation and Attractions (2022b). Wildlife Conservation (rare flora) Notice. Available from: http://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants.

Department of Biodiversity, Conservation and Attractions (2022c). List of threatened ecological communities endorsed by the Western Australia Minister for Environment, Species and Communities Branch, Government of Western Australia. Available from: https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/wa-s-threatened-ecological-communities.

Department of Biodiversity, Conservation and Attractions (2022d). Priority ecological communities for Western Australia, Species and Communities Branch, Department of Biodiversity, Conservation and Attractions. Available from: https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/wa-s-threatened-ecological-communities.

Department of Environment and Conservation (2013). Definitions, categories and criteria for threatened and priority ecological communities.<https://www.dpaw.wa.gov.au/images/plants-animals/threatened-species/definitions_categories_and_criteria_for_threatened_and_priority_ecological_communities>

Department of Climate Change, Energy, the Environment and Water (2022a). Protected Matters Search Tool. Available from: https://www.environment.gov.au/epbc/protected-matters-search-tool.

Department of Climate Change, Energy, the Environment and Water (2022b). EPBC Act list of threatened ecological communities, Commonwealth of Australia. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publiclookupcommunities.pl.

Department of Climate Change, Energy, the Environment and Water (2022c). *Weeds of National Significance. h*ttp://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html

Department of Parks and Wildlife 2017, *Procedures for the assessment, identification and demarcation of old-growth forest.* Prepared Department of Parks and Wildlife, March 2017.

Department of Parks and Wildlife (2022a). NatureMap: Mapping Western Australia's biodiversity, Government of Western Australia. Available from: https://naturemap.dpaw.wa.gov.au

Department of Parks and Wildlife (2022b). *DPaW Swan Weed Assessment. Excel spreadsheet produced for the Invasive Plant Prioritisation Process for the Department of Environment and Conservation.* < http://www.dpaw.wa.gov.au/plants-and-animals/plants/weeds/156-how-does-dpaw-manage-weeds>

Department of Primary Industries and Regional Development (2022), *Western Australian Organism List*, Government of Western Australia. Available from: https://www.agric.wa.gov.au/bam/western-australian-organism-list-waol.

EPA (2014) WA Environmental Offsets Guidelines. August 2014.

Environmental Protection Authority (2016a). *Statement of Environmental Principles, Factors and Objectives*, Environmental Protection Authority, Western Australia.

Environmental Protection Authority (2016b). *Environmental Factor Guideline: Flora and Vegetation*, Environmental Protection Authority, Western Australia.

Environmental Protection Authority (2016c). *Technical Guidance – Flora and vegetation surveys for environmental impact assessment*, Environmental Protection Authority, Western Australia.

Executive Steering Committee for Australian Vegetation Information 2003, *Australian vegetation attribute manual: National vegetation information system, version 6.0*, Department of the Environment and Heritage, Canberra.

Gardner, J. H., and D. T. Bell. 2007. Bauxite mining restoration by Alcoa World Alumina Australia in Western Australia: social, political, historical and environmental contexts. Restoration Ecology Supplement 15:S3–S10.

Grant, C.D., J.M. Koch, R. D. Smith, and S.J. Collins (1998). A review of prescription burning in rehabilitated bauxite mines in Western Australia, CALM Science 2: 357-371.

Grant, C.D., W.A. Loneragan, J.M. Koch and D.T. Bell (1997). Fuel characteristics, vegetation structure and fire behaviour of 11-15 year old restored bauxite mines in Western Australia. Australian Forestry 60: 147-157.

Grant, C. D. and Loneragan, W. A. (1999). *The effects of burning on the understorey composition of 11 – 13-year-old rehabilitated bauxite mines in Western Australia*. Plant Ecology 145: 291 – 305.

Grant, C.D., M.A. Smith, an M.A. Norman (2007). Fire and silvicultural management of restored bauxite mines in Western Australia. Restoration Ecology Supplement 15: S127 – S136.

Gentilli, J. (1998). Climate of the Jarrah Forest. In: Dell, B., Havel, J. J. and Malajczuk, N. (Eds), *The Jarrah Forest*. Kluwer Academic Publishers, Dordrecht, 23 – 40.

Government of Western Australia (2019). 2018 Southwest Vegetation Complex Statistics. Current as of March 2019. WA Department of Biodiversity, Conservation and Attractions, Perth.

Havel, J. J. (1975a). Site-Vegetation Mapping in the Northern Jarrah Forest (Darling Range 1). I. Definition of site and vegetation types. *Bull. For. Dept. West. Aust* **86.**

Havel, J. J. (1975b). Site-vegetation mapping in the Northern Jarrah Forest (Darling Range). II. Location and mapping of site-vegetation types. *Bull. For. Dept. West. Aust.* **87.**

Havel, J.J. (2000). Ecology of the forests of southwestern Australia in relation to climate and landforms. Ph.D. Thesis, Murdoch University, Perth, Western Australia.

Heddle, E.M., Loneragan, O.W. and Havel, J.J. (1980). 'Vegetation complexes of the Darling System, Western Australia' In: *Atlas of Natural Resources Darling System Western Australia explanatory text,* pp 37-72. University of Western Australia Press, Western Australia.

Keighery, B. J. (1994). *Bushland Plant Survey. A Guide to Plant Community Survey for the Community.* Wildflower Society of WA (Inc.), Western Australia.

Koch, J.M. (2007a). Restoring a jarrah forest understorey vegetation after bauxite mining in Western Australia. Restoration Ecology Supplement 15: S26-S39.

Koch, J.M. (2007b). Alcoa's Mining and Restoration Process in South Western Australia. In: Restoration Ecology, Vol 15, No.4 (supplement), pp. S11-S16.

Koch, J.M. and Hobbs R.J. (2007). Synthesis: Is Alcoa Successfully Restoring a Jarrah Forest Ecosystem after Bauxite Mining in Western Australia. In: Restoration Ecology, Vol 15, No.4 (supplement), pp. S137-S144.

Koch, J.M. and G.P. Samsa (2007).Restoring jarrah forest trees after bauxite mining in Western Australia. Restoration Ecology Supplement 15: S17-S25.

Mattiske, E.M. and Associates 1988, Vegetation Survey - Huntly North. Unpublished report prepared for Alcoa of Australia Limited.-

Mattiske E.M. and Associates 1987, *Flora and Vegetation Survey. Eastern Jarrah Forest.* Unpublished report prepared for Alcoa of Australia Ltd, Perth.

Mattiske, E.M. and Associates 1992, Site-vegetation Types South Jarrahdale, Chandler and Kingsbury Drive Areas. Unpublished report prepared for Alcoa of Australia Limited.

Mattiske, E.M. and Associates 1993, Botanical Studies Huntly Area. Unpublished report prepared for Alcoa of Australia Limited.

Mattiske, E.M. and Havel, J.J. 1998, Vegetation Complexes of the South-west Forest Region of Western Australia. Maps prepared as part of the Regional Forest Agreement, Western Australia for the Department of Conservation and Land Management and Environment Australia.

Mattiske Consulting Pty Ltd 2006, Vegetation Monitoring in the Intermediate Rainfall zone in the Jayrup, Cameron and Gordon Catchments. Unpublished report prepared for Alcoa of Australia Limited.

Mattiske Consulting Pty Ltd 2009, Flora and Vegetation of O'Neill Survey Area. Unpublished report prepared for Alcoa of Australia Limited.

Mattiske Consulting Pty Ltd 2009b, Vegetation Assessment of the Wungong Catchment. Unpublished report prepared for the Water Corporation, May 2009.

Mattiske Consulting Pty Ltd 2011, Flora and Vegetation of Myara Survey Area. Unpublished report prepared for Alcoa of Australia Limited.

Mattiske Consulting Pty Ltd 2011b, Vegetation Assessment of the Wungong Catchment, Treatment Area 4 – Curtis Road, Bedfordale. Unpublished report prepared for the Water Corporation, February 2011.

Mattiske Consulting Pty Ltd 2011c, Flora and Vegetation Assessment of 31 Mile Brook, Unpublished report prepared for the Water Corporation, 2011.

Mattiske Consulting Pty Ltd 2012, Flora and Vegetation of Myara Survey Area. Unpublished report prepared for Alcoa World Alumina Australia Limited.

Mattiske Consulting Pty Ltd 2015, Flora and Vegetation of the South Keats and Larego Survey areas. Unpublished report prepared for Alcoa World Alumina Australia, August 2015.

Mattiske Consulting Pty Ltd 2018, Flora and Vegetation Assessment – Vaquita: Alcoa Grid Reference Blocks G5416, H5413, H5414 and H5417. Unpublished report prepared for Alcoa of Australia Limited, August 2018.

Mattiske Consulting Pty Ltd 2019a, Flora & Vegetation Assessment of the Huntly Expansion Areas. Unpublished report prepared for Alcoa of Australia Limited.

Mattiske Consulting Pty Ltd 2019b, Flora and Vegetation Assessment of the Larego Area. Unpublished report prepared for Alcoa of Australia Limited, September 2019.

Mattiske Consulting Pty Ltd 2020, Flora and Vegetation Assessment of the Larego Area. Unpublished report prepared for Alcoa of Australia Limited, May 2020.

Mattiske Consulting Pty Ltd 2021, Pinjarra Alumina Refinery Revised Proposal. Detailed Flora and Vegetation Survey for Huntly Mine - Holyoake. Unpublished report prepared for Alcoa of Australia Limited, July 2021.

Ministerial Council on Mineral and Petroleum Resources (MCMPR) (2005). *Principles for Engagement with Communities and Stakeholders*.

Nichols, O.G. and C.D. Grant (2007). Vertebrate fauna recolonisation of restored bauxite mine – key findings from almost 30 years of monitoring and research. Restoration Ecology Supplement 15: S116-S126.

Nichols, O.G. and D.V. Michaelsen (1986). Successional trends in bauxite mines rehabilitated using three topsoil return techniques. Forest Ecology and Management 14: 163-175.

Norman, M.A., J.M. Koch, C.D. Grant, T.K. Morald, and S.C. Ward (2006). Vegetation succession after bauxite mining in Western Australia. Restoration Ecology 14: 278-288.

Thackway, R. and Cresswell, I. D. (1995). *An Interim Biogeographic Regionalisation for Australia: a framework for setting priorities in the national reserves system cooperative program.* Australian Nature Conservation Agency, Canberra.

Thiele, K.R. (2019). *A revision of the Hibbertia commutata (Dilleniaceae) species group.* Australian Systematic Botany 32(1), 71-109 (May 2019).

Whitford, K.R. (2002). *Hollows in jarrah (Eucalyptus marginata) and marri (Corymbia calophylla) trees. I. Hollow sizes, tree attributes and ages.* Forest Ecology and Management 160: 201-214.

Williams, K. & Mitchell, D. (2001). 'Jarrah Forest 1 (JF1 – Northern Jarrah Forest subregion)' in A biodiversity audit of Western Australia's 53 biogeographical subregions in 2002, eds. JE May & NL McKenzie, Department of Conservation and Land Management, Western Australia, pp. [369-381].

6 Appendices

Appendix 1 – Potential Occurrence of Threatened and Priority Flora Species within or near mine regions

Species	SCC	FCC	Lifeform & Habit	Landform, Soil type, Baserock	Optimal Timeframe	SubType Category	Associated Havel Site Types	Historic Records	Distribution	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION	KEATS
Andersonia sp. Saxatilis (F. & J. Hort 3324)	T	CR	Perennial Shrub	Gravelly clay Granite outcrops	Sep - Oct	Granite	G/R	Myara: 0 - 10 km O'Neil: 0 - 10 km Holyoake: >20km Arundel: >20km Orion: >20km Keats: >20km Larego: >20km	Myara: Yes O'Neil: Yes Holyoake: No Arundel: No Orion: No Keats: No Larego: No	High	High	Low	Low	Low	Low
Anthocercis gracilis	T	VU	Perennial Shrub	Sandy or loamy soils Granite outcrops	Sep - Oct	Granite	G/R	Myara: Inside O'Neil: 10 - 20 km Holyoake: 10 - 20 km Arundel: >20km Orion: 0 - 10 km Keats: >20km Larego: >20km	Myara: Yes O'Neil: Yes Holyoake: Yes Arundel: Yes Orion: Yes Keats: Yes Larego: Yes	High	Moderate	Moderate	Moderate	High	Moderate
Caladenia leucochila	T	EN	Perennial Herb	Valley floors sand	Aug - Oct	Upland Forest (Sand)	P	Myara: >20 km O'Neil: >20 km Holyoake: 10 - 20 km Arundel: 0 - 10 km Orion: Inside Keats: Inside Larego: Inside	Myara: No O'Neil: No Holyoake: No Arundel: Yes Orion: Yes Keats: Yes Larego: Yes	Low	Low	High	High	High	High

Species	SCC	FCC	Lifeform & Habit	Landform, Soil type, Baserock	Optimal Timeframe	SubType Category	Associated Havel Site Types	Historic Records	Distribution	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION	KEATS
Morelotia australiensis	T	VU	Perennial Sedge	Flats, well-drained areas. Sand, sandy loam.	Year-round	Upland Forest (Sand)	P	Myara: 0 - 10 km O'Neil: 0 - 10 km Holyoake: >20 km Arundel: 0 - 10 km Orion: 0 - 10 km Keats: >20 km Larego: 0 - 10 km	Myara: Yes O'Neil: Yes Holyoake: Yes Arundel: Yes Orion: Yes Keats: Yes Larego: Yes	High	High	High	High	High	Moderate
Darwinia hortiorum	P1	-	Perennial Shrub	Shallow granitic soils, loam or loam/clay associated with laterite. Granite outcrops	Year-round	Upland Forest (Loam) / GDE / Granite	S/T /A/C /W /D/G/R	Myara: 0 - 10 km O'Neil: Inside Holyoake: 10 - 20 km Arundel: >20km Orion: >20km Keats: >20km Larego: >20km	Myara: Yes O'Neil: Yes Holyoake: No Arundel: No Orion: No Keats: No Larego: No	High	High	Low	Low	Low	Low
Deyeuxia inaequalis	P1	-	Annual Grass	Loam	Oct	Upland Forest (Loam)	S/T	Myara: >20km O'Neil: >20km Holyoake: 10 - 20 km Arundel: 0 - 10 km Orion: Inside Keats: 10 - 20 km Larego: 10 - 20 km	Myara: No O'Neil: No Holyoake: No Arundel: No Orion: No Keats: No Larego: No	Low	Low	Moderate	High	High	Moderate

Species	SCC	FCC	Lifeform & Habit	Landform, Soil type, Baserock	Optimal Timeframe	SubType Category	Associated Havel Site Types	Historic Records	Distribution	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION	KEATS
Hibbertia acrotoma	P1	-	Perennial Shrub	Steep hillsides and Slopes Brown Loam Granite outcrops	Year-round	Granite	G/R	Myara: Inside O'Neil: 10 - 20 km Holyoake: 10 - 20 km Arundel: 0 - 10 km Orion: 0 - 10 km Keats: 10 - 20 km Larego: 10 - 20 km	Myara: Yes O'Neil: No Holyoake: No Arundel: Yes Orion: Yes Keats: No Larego: Yes	High	Low	High	High	High	Low
Hibbertia hortiorum	P1	-	Perennial Shrub	Slopes Brown sandy gravels	Year-round	Upland Forest (Sand)	P	Myara: Inside O'Neil: 0 - 10 km Holyoake: 10 - 20 km Arundel: >20km Orion: >20km Keats: >20km Larego: >20km	Myara: Yes O'Neil: Yes Holyoake: Yes Arundel: No Orion: No Keats: No Larego: No	High	High	Low	Low	Low	Low
Netrostylis sp. Nannup (P.A. Jurjevich 1133)	P1	-	Perennial Sedge	Creeklines Clay loam	Year-round	GDE	A/C/W/D	Myara: >20km O'Neil: >20km Holyoake: >20km Arundel: 0 - 10 km Orion: 0 - 10 km Keats: 0 - 10 km Larego: Inside	Myara: No O'Neil: No Holyoake: No Arundel: No Orion: No Keats: No Larego: No	Low	Low	High	High	High	High

Species	SCC	FCC	Lifeform & Habit	Landform, Soil type, Baserock	Optimal Timeframe	SubType Category	Associated Havel Site Types	Historic Records	Distribution	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION	KEATS
Paracaleana gracilicordata	P1	-	Perennial Herb	Growing on moss mats, Granite outcrops	Oct - Nov	Granite	G/R	Myara: 0 - 10 km O'Neil: 0 - 10 km Holyoake: >20km Arundel: >20km Orion: >20km Keats: >20km Larego: >20km	Myara: Yes O'Neil: Yes Holyoake: No Arundel: No Orion: No Keats: No Larego: No	High	High	Low	Low	Low	Low
Paracaleana granitica	P1	-	Perennial Herb	rowing on moss mats, Granite outcrops	Oct - Dec	Granite	G/R	Myara: 0 - 10 km O'Neil: 0 - 10 km Holyoake: >20km Arundel: >20km Orion: >20km Keats: >20km Larego: >20km	Myara: Yes O'Neil: Yes Holyoake: No Arundel: No Orion: No Keats: No Larego: No	High	High	Low	Low	Low	Low
Grevillea ornithopoda	P2	-	Perennial Shrub	Edge of river bank and creek, dunes Loam, loam over clay, sand, clay.	Sep - Dec	GDE	A/C/W/D	Myara: 0 - 10 km O'Neil: 10 - 20 km Holyoake: 0 - 10 km Arundel: 10 - 20 km Orion: Inside Keats: 0 - 10 km Larego: 10 - 20 km	Myara: Yes O'Neil: Yes Holyoake: Yes Arundel: Yes Orion: Yes Keats: Yes Larego: Yes	Moderate	Low	Moderate	Moderate	High	Moderate

Species	SCC	FCC	Lifeform & Habit	Landform, Soil type, Baserock	Optimal Timeframe	SubType Category	Associated Havel Site Types	Historic Records	Distribution	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION	KEATS
Lepyrodia curvescens	P2	-	Perennial Rush	Seasonally inundated swampland. Sand, laterite.	Year-round	GDE	A/C/W/D	Myara: 0 - 10 km O'Neil: Inside Holyoake: 10 - 20 km Arundel: 10 - 20 km Orion: 0 - 10 km Keats: >20km Larego: >20km	Myara: Yes O'Neil: Yes Holyoake: Yes Arundel: No Orion: No Keats: No Larego: No	High	High	Low	Low	Moderate	Low
Schizaea rupestris	P2	-	Perennial Fern	Gullies, creek banks, shaded moist rock faces.. rock faces. Sand.		GDE	A/C/W/D	Myara: >20km O'Neil: >20km Holyoake: >20km Arundel: 0 - 10 km Orion: 0 - 10 km Keats: 0 - 10 km Larego: Inside	Myara: No O'Neil: No Holyoake: No Arundel: Yes Orion: Yes Keats: Yes Larego: Yes	Low	Low	High	High	High	High
Tetratheca phoenix	P2	-	Perennial Shrub	mid-upper slopes, Brown gravelly loam over granite. M often near large rock outcrops.	Year-round	Upland Forest (Loam) / Granite	S/T/G/R	Myara: Inside O'Neil: 0 - 10 km Holyoake: 10 - 20 km Arundel: >20km Orion: >20km Keats: >20km Larego: >20km	Myara: Yes O'Neil: Yes Holyoake: No Arundel: No Orion: No Keats: No Larego: No	High	High	Low	Low	Low	Low

Species	SCC	FCC	Lifeform & Habit	Landform, Soil type, Baserock	Optimal Timeframe	SubType Category	Associated Havel Site Types	Historic Records	Distribution	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION	KEATS
Acacia drummondii subsp. affinis	P3	-	Perennial Shrub	Lateritic gravelly soils.	Year-round	Upland Forest (Loam)	S/T	Myara: Inside O'Neil: 10 - 20 km Holyoake: >20km Arundel: >20km Orion: >20km Keats: >20km Larego: >20km	Myara: No O'Neil: No Holyoake: No Arundel: No Orion: No Keats: No Larego: No	High	High	Low	Low	Low	Low
Actinotus repens	P3	-	Perennial Herb	creek banks. Roadside ditches Sandy clay, mud	Year-round	GDE	A/C/W/D	Myara: >20km O'Neil: >20km Holyoake: 10 - 20 km Arundel: 0 - 10 km Orion: Inside Keats: 0 - 10 km Larego: Inside	Myara: No O'Neil: No Holyoake: Yes Arundel: Yes Orion: Yes Keats: Yes Larego: Yes	Low	Low	High	High	High	High
Andersonia sp. Audax (F. Hort, B. Hort & J. Hort 3179)	P3	-	Perennial Shrub	drainage lines Granite, slopes Loam, clay, sand, gravel. granite outcrops	Year-round	Granite / GDE	A/C/W/D/G/R	Myara: 0 - 10 km O'Neil: Inside Holyoake: 10 - 20 km Arundel: >20km Orion: >20km Keats: >20km Larego: >20km	Myara: Yes O'Neil: Yes Holyoake: Yes Arundel: No Orion: No Keats: No Larego: No	High	High	Low	Low	Low	Low

Species	SCC	FCC	Lifeform & Habit	Landform, Soil type, Baserock	Optimal Timeframe	SubType Category	Associated Havel Site Types	Historic Records	Distribution	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION	KEATS
Cyathochaeta teretifolia	P3	-	Perennial Herb	Swamps, creek edges. Grey sand, sandy clay.	Year-round	GDE	A/C/W/D	Myara: Inside O'Neil: 10 - 20 km Holyoake: 10 - 20 km Arundel: 0 - 10 km Orion: 0 - 10 km Keats: 0 - 10 km Larego: Inside	Myara: Yes O'Neil: Yes Holyoake: Yes Arundel: Yes Orion: Yes Keats: Yes Larego: Yes	High	High	High	High	High	High
Grevillea dissectifolia	P3	-	Perennial Shrub	Roadsides Gravelly loam,		Upland Forest (Sand) / Upland Forest (Loam) / GDE	P/S/T/A/C/W/D	Myara: 0 - 10 km O'Neil: Inside Holyoake: 0 - 10 km Arundel: 10 - 20 km Orion: 0 - 10 km Keats: 10 - 20 km Larego: >20km	Myara: Yes O'Neil: Yes Holyoake: Yes Arundel: Yes Orion: Yes Keats: Yes Larego: Yes	Moderate	High	Low	Moderate	Low	Low
Grevillea prominens	P3	-	Perennial Shrub	Along creeklines. Gravelly loam.	Year-round	GDE	A/C/W/D	Myara: >20km O'Neil: >20km Holyoake: >20km Arundel: Inside Orion: 0 - 10 km Keats: 0 - 10 km Larego: Inside	Myara: No O'Neil: No Holyoake: No Arundel: Yes Orion: Yes Keats: Yes Larego: Yes	Low	Low	High	High	High	High

Species	SCC	FCC	Lifeform & Habit	Landform, Soil type, Baserock	Optimal Timeframe	SubType Category	Associated Havel Site Types	Historic Records	Distribution	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION	KEATS
Hakea oldfieldii	P3	-	Perennial Shrub	Seasonally wet flats. Red clay or sand over laterite	Year-round	GDE	A/C/W/D	Myara: 10 - 20 km O'Neil: 0 - 10 km Holyoake: Inside Arundel: >20km Orion: 10 - 20 km Keats: >20km Larego: >20km	Myara: No O'Neil: Yes Holyoake: Yes Arundel: Yes Orion: Yes Keats: Yes Larego: Yes	Low	High	Moderate	Moderate	Moderate	Moderate
Lepyrodia heleocharoides	P3	-	Perennial Rush	swamps. Dry or seasonally inundated heath or woodland Moist peaty sand. ,	Year-round	GDE	A/C/W/D	Myara: Inside O'Neil: 10 - 20 km Holyoake: >20km Arundel: >20km Orion: >20km Keats: >20km Larego: >20km	Myara: Yes O'Neil: Yes Holyoake: Yes Arundel: Yes Orion: Yes Keats: Yes Larego: Yes	High	Moderate	Moderate	Moderate	Moderate	Moderate
Meionectes tenuifolia	P3	-	Annual Herb	Winter wet flats Grey sand, clay.	Sep - Dec	GDE	A/C/W/D	Myara: Inside O'Neil: 10 - 20 km Holyoake: 10 - 20 km Arundel: 10 - 20 km Orion: 10 - 20 km Keats: 10 - 20 km Larego: 10 - 20 km	Myara: Yes O'Neil: Yes Holyoake: Yes Arundel: Yes Orion: Yes Keats: Yes Larego: Yes	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

Species	SCC	FCC	Lifeform & Habit	Landform, Soil type, Baserock	Optimal Timeframe	SubType Category	Associated Havel Site Types	Historic Records	Distribution	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION	KEATS
Stackhousia sp. Red-blotched corolla (A. Markey 911)	P3	-	Perennial Herb	Slopes. Brown loamy sand, clayey sand over laterite, white sandy clay over granite, grey clay.	Jun - Sep	Upland Forest (Sand) / Upland Forest (Loam) / Granite	P/S/T/G/R	Myara: 0 - 10 km O'Neil: 10 - 20 km Holyoake: >20km Arundel: >20km Orion: >20km Keats: >20km Larego: >20km		Low	-	Low	-	Low	-
Tetratheca parvifolia	P3	-	Perennial Shrub	Dry gravelly red soil with granite	Year-round	Upland Forest (Loam) / Granite	S/T/G/R	Myara: >20km O'Neil: >20km Holyoake: >20km Arundel: 10 - 20 km Orion: 10 - 20 km Keats: 10 - 20 km Larego: Inside		Low	-	High	-	Low	-
Tetratheca pilifera	P3	-	Perennial Shrub	Gravelly soils	Year-round	Upland Forest (Loam) / Upland Forest (Sand)	P/S/T	Myara: >20km O'Neil: 10 - 20 km Holyoake: 10 - 20 km Arundel: 10 - 20 km Orion: 0 - 10 km Keats: 10 - 20 km Larego: >20km		Moderate	-	-	-	-	-

Species	SCC	FCC	Lifeform & Habit	Landform, Soil type, Baserock	Optimal Timeframe	SubType Category	Associated Havel Site Types	Historic Records	Distribution	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION	KEATS
Cyanothamnus tenuis	P4	-	Perennial Shrub	Laterite, stony soils granite outcrops	Year-round	Upland Forest (Loam) / Upland Forest (Sand) / Granite	P/S/T/G/R	Myara: Inside O'Neil: 10 - 20 km Holyoake: 10 - 20 km Arundel: 0 - 10 km Orion: 0 - 10 km Keats: 10 - 20 km Larego: Inside		High	-	High	-	High	-
Eucalyptus x graniticola	P4	-	Perennial Tree	Exposed granite slopes. granite outcrops	Year-round	Granite	G/R	Myara: 10 - 20 km O'Neil: >20km Holyoake: 10 - 20 km Arundel: Inside Orion: 0 - 10 km Keats: 10 - 20 km Larego: 0 - 10 km		Low	-	Moderate	-	Moderate	-
Grevillea pimeleoides	P4	-	Perennial Shrub	Rocky hillsides Gravelly soils over granite.	Year-round	Granite	G/R	Myara: Inside O'Neil: 0 - 10 km Holyoake: >20km Arundel: >20km Orion: >20km Keats: >20km Larego: >20km		Low	-	Low	-	Low	-

Species	SCC	FCC	Lifeform & Habit	Landform, Soil type, Baserock	Optimal Timeframe	SubType Category	Associated Havel Site Types	Historic Records	Distribution	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION	KEATS
Hemigenia platyphylla	P4	-	Perennial Shrub	slopes. Sandy & loamy soils. granite outcrops	Year-round	Upland Forest (Loam) / Upland Forest (Sand) / Granite	P/S/T/G/R	Myara: 0 - 10 km O'Neil: 0 - 10 km Holyoake: >20km Arundel: >20km Orion: >20km Keats: >20km Larego: >20km		Low	-	Low	-	Low	-
Parsonsia diaphanophleba	P4	-	Perennial Shrub	Along rivers. Alluvial soils.	Year-round	GDE	A/C/W/D	Myara: 0 - 10 km O'Neil: >20km Holyoake: 0 - 10 km Arundel: 10 - 20 km Orion: Inside Keats: 0 - 10 km Larego: 10 - 20 km		Low	-	Low	-	Low	-
Pimelea rara	P4	-	Perennial Shrub	Lateritic soils.	Year-round	Upland Forest (Loam) / Upland Forest (Sand)	P/S/T	Myara: Inside O'Neil: 0 - 10 km Holyoake: 0 - 10 km Arundel: 0 - 10 km Orion: Inside Keats: 0 - 10 km Larego: 10 - 20 km		High	-	High	-	High	-

Species	SCC	FCC	Lifeform & Habit	Landform, Soil type, Baserock	Optimal Timeframe	SubType Category	Associated Havel Site Types	Historic Records	Distribution	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION	KEATS
Senecio leucoglossus	P4	-	Annual Herb	slopes. Gravelly lateritic or granitic soils. Granite outcrops,	Year-round	Granite / Upland Forest (Sand) / Upland Foest (Loam)	P/S/T/G/R	Myara: 0 - 10 km O'Neil: 0 - 10 km Holyoake: 0 - 10 km Arundel: Inside Orion: 0 - 10 km Keats: 0 - 10 km Larego: Inside		High	-	High	-	High	-
Stylidium ireneae	P4	-	Perennial Herb	Valleys near creek lines, woodland, often with Agonis Sandy loam.	Oct - Dec	GDE / Upland Forest (Sand) / Upland Foest (Loam)	P/S/T/A/C/W/D	Myara: Inside O'Neil: 0 - 10 km Holyoake: 0 - 10 km Arundel: 0 - 10 km Orion: Inside Keats: 0 - 10 km Larego: 0 - 10 km		High	-	High	-	High	-

Appendix 2 – Summary of Key Introduced or Weed Species with the potential to occur within the Huntly and Willowdale mine areas

Note – Huntly includes all areas north of the Dwellingup – Boddington/Williams Road; Willowdale includes all areas south of the Dwellingup – Boddington/Williams Road

Ecological impact: H = High, M = Medium, L = Low, U = Unknown

Invasiveness: S = Slow, M = Moderate, R = Rapid, U = Unknown

Species	**Federal Listing WONS (DCCEEW 2022c)**	**State Listings (DPIRD 2022)**	Environmental Weeds – Ecological Impact (DPAW 2022b)	Environmental Weeds – Invasiveness (DPAW 2022b)	Huntly Mine – Myara/Myara North/O'neil	Willowdale Mine - Arundel, Orion, Keats, Larego
**Acacia decurrens*	No	Permitted - s11	L	S	Low	Moderate
**Acacia floribunda*	No	Permitted - s11			Moderate	Low
**Acacia iteaphylla*	No	Permitted - s11	U	R	Low	Low
**Acacia longifolia* (Andrews) Willd. subsp. *longifolia*	No	Permitted - s11	U	M	Low	Low
**Acacia podalyriifolia*	No	Permitted - s11	L	S	Low/ Moderate	Low
**Acacia pycnantha*	No	Permitted - s11	L	S	Low	Moderate
**Aira caryophyllea*	No	Permitted - s11	U	R	Moderate	Low
**Aira cupaniana*	No	Permitted - s11	U	R	Moderate	Moderate
**Aira praecox*	No	Permitted - s11	U	U	Moderate	Moderate
**Allium triquetrum*	No	Permitted - s11	L	S	Low	Low
**Arctotheca calendula*	No	Permitted - s11	M	M	Moderate	Moderate
**Asparagus asparagoides*	Yes	Declared Pest - s22(2)	H	R	Moderate	Low

Species	Federal Listing WONS (DCCEEW 2022c)	State Listings (DPIRD 2022)	Environmental Weeds – Ecological Impact (DPAW 2022b)	Environmental Weeds – Invasiveness (DPAW 2022b)	Huntly Mine – Myara/Myara North/O'neil	Willowdale Mine - Arundel, Orion, Keats, Larego
**Avena barbata*	No	Permitted - s11	H	R	Low	Low
**Avena fatua*	No	Permitted - s11	H	R	Low	Low
**Babiana angustifolia*	No	Permitted - s11	H	M	Moderate	Low
**Bellardia trixago*	No	Permitted - s11			Low	Low
**Bellardia viscosa*	No				Low	Low
**Briza maxima*	No	Permitted - s11 Permitted - s11	U	R	High	High
**Briza minor*	NO	Permitted - s11	U	R	Moderate	Moderate
**Bromus diandrus*	No	Permitted - s11	H	R	Moderate	Low
**Callistemon citrinus*	No	Permitted - s11			Low	Low
**Callitris endlicheri*	No	Permitted - s11			Low	Low
**Centaurium erythraea*	No	Permitted - s11	U	R	Moderate	Low
**Chenopodium album*	No	Permitted - s11	U	M	Low	Low
**Chenopodium murale*	No	Permitted - s11	U	M	Low	Low

Species	Federal Listing WONS (DCCEEW 2022c)	State Listings (DPIRD 2022)	Environmental Weeds – Ecological Impact (DPAW 2022b)	Environmental Weeds – Invasiveness (DPAW 2022b)	Huntly Mine – Myara/Myara North/O'neil	Willowdale Mine - Arundel, Orion, Keats, Larego
**Chrysanthemoides monilifera*	Yes	Declared Pest, Prohibited - s12			Low	Low
**Chrysanthemoides monilifera* subsp. *monilifera*	Yes	Declared Pest, Prohibited - s12			Low	Low
**Cortaderia selloana* subsp. *selloana*	No	Permitted – s11	H	R	Low	Low
**Cotula coronopifolia*	No	Permitted – s11	U	R	Low	Low
**Cyperus congestus*	No	Permitted – s11	U	M	Low	Low
**Cyperus tenellus*	No	Permitted – s11	U	R	Moderate	Low
**Ehrharta calycina*	No	Permitted – s11	U	M	Low	Low
**Erigeron sumatrensis*	No	Permitted – s11			Low	Low
**Erodium botrys*	No	Permitted – s11	U	M	Low	Low
**Eschsholzia californica*	No	Permitted – s11			Low	Low
**Eucalyptus microcorys*	No	Permitted – s11	U	U	Moderate	Moderate
**Eucalyptus saligna*	No		U	U	Low	Moderate
**Galium murale*	No	Permitted – s11	L	U	Low	Moderate
**Gomphocarpus fruticosus*	No	Declared Pest - s22(2)	U	R	Moderate	Low
**Hypericum perforatum*	No	Permitted – s11	U	M	Low	Low
**Hypochaeris glabra*	No	Permitted – s11	M	R	High	High
**Lilium candidum*	No	Permitted – s11			Low	Moderate
**Lonicera japonica*	No	Permitted – s11	U	S	Low	Moderate
**Lysimachia arvensis*	No	Permitted – s11	U	R	High	High
**Medicago polymorpha*	No	Permitted – s11			Low	Moderate
**Melia azedarach*	No	Permitted – s11			Low	Moderate
**Orobanche minor*	No	Declared Pest, Prohibited - s12	U	R	Low	Moderate
**Oxalis pes-caprae*	No	Permitted – s11	H	S	Low	Low
**Phytolacca octandra*	No	Permitted – s11	U	M	Moderate	Moderate

Species	**Federal Listing WONS (DCCEEW 2022c)**	**State Listings (DPIRD 2022)**	Environmental Weeds – Ecological Impact (DPAW 2022b)	Environmental Weeds – Invasiveness (DPAW 2022b)	Huntly Mine – Myara/Myara North/O'neil	Willowdale Mine - Arundel, Orion, Keats, Larego
**Pinus pinaster*	No	Permitted – s11	M	R	Low	Low
**Quercus palustris*	No	Permitted – s11			Low	Low
**Rubus anglocandicans*	No	Declared Pest - s22(2)	H	M	Moderate	Moderate
**Rubus laudatus*	No	Declared Pest - s22(2)	H	M	Moderate	Moderate
**Rubus ulmifolius*	No	Declared Pest - s22(2)	H	M	Moderate	Moderate
**Rubus ulmifolius* var. *ulmifolius*	No	Declared Pest - s22(2)	H	M	Moderate	Moderate
**Senecio vulgaris*	No	Permitted – s11	L	M	Low	Low
**Sonchus oleraceus*	No	Permitted – s11	M	R	Moderate	Moderate
**Syncarpia glomulifera*	No	Permitted – s11			Low	Low
**Ursinia anthemoides*	No	Permitted – s11	U	R	Moderate	Moderate
**Vellereophyton dealbatum*	No	Permitted – s11	M	R	Moderate	Moderate
**Vinca major*	No	Permitted – s11	H	S	Low	Low
**Zantedeschia aethiopica*	No	Declared Pest - s22(2)	H	M	Moderate	Low

Appendix 3 - Risk Assessment

Risk Outcome Matrix

Consequence	Likelihood				
	Rare	Unlikely	Possible	Likely	Almost Certain
Critical	Medium	Medium	High	Very High	Very High
Major	Low	Medium	High	High	Very High
Moderate	Low	Medium	Medium	High	High
Minor	Low	Low	Medium	Medium	Medium
Insignificant	Low	Low	Low	Low	Medium

Likelihood Descriptors (likelihood of consequence occurring)

Likelihood Descriptor	Description	Guidance
Almost certain or Frequent	Expected to occur	A similar outcome has arisen several times per year in local operations
Likely or Probable	More likely to occur than not occur.	A similar outcome has arisen several times per year in Alcoa operations worldwide or broader industry
Possible or Occasional	As likely to occur as not to occur.	A similar outcome has arisen at some time previously in local operations
Unlikely or Remote	Not impossible, more likely not to occur than to occur.	A similar outcome has arisen at some time previously in Alcoa operations worldwide or broader industry
Rare or Improbable	Very unlikely to occur.	No experience of this happening in the broader worldwide industry but is theoretically possible

Consequence Descriptors

Aspect	Insignificant	Minor	Moderate	Major	Catastrophic
Vegetation	Minor temporary and localised change to vegetation extent and quality	Localised short term, minor change to vegetation extent and quality	Localised medium to long term or local scale change to vegetation extent and quality	Regional or long-term change to vegetation extent and quality	Irreversible change to vegetation extent and quality; or Results in changes in conservation status of significant species or ecosystems
Conservation Significant Flora	Minor temporary and localised impact on conservation significant species. No direct loss of conservation significant flora in local area although increased stress incurred through indirect impacts.	Minor, localised loss of conservation significant flora through direct or indirect impacts.	Moderate local and minor regional loss of conservation significant flora with no impacts on species survival.	Major regional loss that places significant pressure on continued survival of conservation significant species.	Project results in extinction of conservation significant species on a regional scale.
Contamination of Soils	Minimal land contamination within localised area, easily treatable in short term and does not result in adverse impacts on associated environmental values.	Minimal land contamination which is localised and treatable in medium term. Does not result in adverse impacts on associated environmental values.	Low level land contamination within localised area resulting in short to medium term impacts to environmental values.	Low level land contamination on a regional scale resulting in medium to long term impacts on associated environmental values.	Mid-level land contamination on a regional scale resulting in permanent impacts on environmental values.
Erosion	Project activities cause negligible erosion in isolated area.	Project activities lead to limited, localised erosion which does not impact on any environmental values and can be rectified in short term.	Project activities lead to substantial erosion which can be rectified in short term.	Project activities lead to substantial erosion which will require long-term remedial works.	Project activities lead to substantial erosion resulting in long term residual effects.

6.1 Risk assessment

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Direct loss of conservation significant vegetation, communities and flora individuals from clearing	Significant impacts to conservation significant flora populations, vegetation or communities as a result of clearing activities Clearing of threatened flora individuals or communities without regulatory consultation and appropriate approvals	• Implement Mining Avoidance Zones for: ○ Threatened species (unless regulatory consultation and appropriate approvals obtained) ○ DBCA Old growth forest ○ National Park, formal conservation reserves • Implement Mining Exclusion Zones for: ○ Rock outcrops greater than one hectare and biologically diverse areas fringing granite outcrops. ○ Stream Zone vegetation ○ Threatened species (unless regulatory consultation and appropriate approvals obtained)	• Clearing activities undertaken as per Vegetation Management Plan (CDS 2053-5517) • Minimise infrastructure clearing of stream zone vegetation and rock outcrops. • Minimise clearing of mature growth forest. • Forests Products Commission undertakes harvesting activities prior to Alcoa clearing. • Design and construct haul road creek crossings, perpendicular to the creek flow to minimise the area of habitat impacted. • Conduct baseline flora surveys as per Flora and Vegetation Management Plan • Conduct pre-clearance surveys in suitable habitat as determined by baseline flora surveys as per Flora	• Rehabilitation to meet Completion Criteria • Rehabilitation to re-instate potential flora habitat	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
		○ Conservation significant flora (as far as practicable) ○ DBCA Old growth forest ○ National Park, formal conservation reserves • Mining Avoidance and Exclusion Zones will be demarcated in construction spatial data to guide construction personnel and included on construction maps.	and Vegetation Management Plan • Spatial data of conservation significant flora and communities retained and review as Surface Disturbance Procedure to ensure clearing impacts are not significant. • If clearing of threatened species is required, then management options will be developed in consultation with DBCA and DCCEEW with appropriate approval obtained under the BC Act and EPBC Act. • Reduce as far as practicable the creation of vegetation islands <10ha in size. • Reduce as far as practicable the creation of vegetation with single connection to larger remnants (peninsulas) • Design and construct haul road creek crossings, perpendicular to the		

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			creek flow to minimise the area of habitat impacted. • Training for all personnel around requirements for licences to handle/remove flora.		
Rehabilitated areas do not meet relevant completion criteria.	Rehabilitation does not provide flora and fauna habitat that aligns with the Northern Jarrah Forest Rehabilitation does not align with post-mining land use. Rehabilitation erosion impacting on water resources	•	• Integrate rehabilitation into mining planning and operational activities. • Undertake rehabilitation activities in a timely and committed way to enable maximisation of progress on rehabilitation areas. • Undertake adaptive management based on research to encourage the return of native species and a self-sustaining forest ecosystem. • Maintain monitoring and assessment to enable rapid responses to invasive weeds and erosion within local areas within the rehabilitation areas. • Maximise the use of all materials used in clearing and rehabilitation	•	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			practices to minimize waste and utilise resources as available (including overburden/topsoil, native seeds, clearing debris, timber logs and waste) • Maintain regular monitoring program at 9 months, 15 months, and ongoing permanent plots to substantiate progress and respond to any issues that arise that will inform adaptive management choices to continually improve outcomes. • Conduct ongoing benchmarking against best practice options. • Active research program for continual improvement.		
Dust deposition impacting upon flora and vegetation	Loss of biodiversity. Loss of flora individuals and/or communities.	•	• Undertake dust suppression activities during high level use of haul roads and conveyors as per internal dust management procedure.	• Minimise open area footprint and rehabilitate or cover (using vegetation, rock, water and/or dust suppressant) exposed areas as soon as practicable	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
	Loss of conservation significant flora or communities. Decline in health and/or change in fauna habitat composition. Decline in health and/or change in vegetation composition.		• Maximise efficiency of loads when transporting ore (including haul trucks and conveyers). • Use dust suppressants on exposed areas where possible. • Investigate alternatives for the wood waste burning of clearing residues to reduce the particulate emissions in the local airshed. • Induction packages – the workforce will be made aware of dust generation and control measures. • Routine housekeeping practices around central facilities and workshops will be implemented to reduce dust generation. • Optimising blast charge sizing and spaces to avoid unnecessary energy releases which has the potential to generate dust. • The location of haul roads, conveyors, mine pits and other		

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			infrastructure gives consideration to separation distance from receptors to reduce air quality impacts. • Maximise efficiency of loads when transporting ore or concentrate (including haul trucks and conveyers).		
Introduction / spread of plant disease to previously un-infested areas outside of approved clearing boundaries, resulting from operations	Loss of biodiversity. Reduction in dieback free soil available for rehabilitation. Decline in health and/or change in vegetation composition. Decline in health and/or change in fauna habitat composition. Impacts to surface water dependent ecosystems (i.e. stream zone vegetation) and water logging sensitive ecosystems. Surface water mechanical	• Infrastructure design to avoid dieback areas, where possible.	• Dieback mapping prior to clearing. • Vehicle clean-down procedures. • Soil Handling procedures - Topsoil, overburden and vegetative material (e.g. coarse woody debris) from uninterpretable or infested areas are not to be moved to uninfected areas. • dieback line (infested, uninfested and uninterpretable areas) demarcation in-field and on GIS and within work packs. • Stockpile signage (demarcating Dieback vs Dieback Free area).	• Fallowing of some dieback areas prior to infrastructure construction	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
	impacts on vegetation e.g. surface water runoff washing plants away, turbid water smothering plants etc.		• Training for all personnel on Dieback Management System. • Weed and seed checks prior to new machinery mobilisation. • Containment of stormwater runoff from identified Dieback infested areas to prevent discharge into uninfested areas. • Revalidation of Dieback assessment every 12 months where construction or operations planned for greater than a 12-month duration. • Rehabilitation plants will only be sourced from nursery suppliers with appropriate dieback control management		
Spread of weeds to previously un-infested areas resulting from operations	Loss of biodiversity. Spread of weed species/impact private residences.	• Undertake dieback mapping.	• Weed and seed procedure prior to mobilisation. • Weed monitoring occurs periodically, particularly in high-risk areas (stream zones and existing roads), so that any infestations	• Management of infested soil after clearing activities	Low

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
	Injury from unstable weed management locations. Exposure to weed management chemicals. Decline in health and/or change in vegetation composition. Decline in health and/or change in fauna habitat composition.		that establish can be eradicated before the plants can flower and set seed. • All identified Weeds of National Significance (WoNS) and environmental weeds treated according to the weed control management outlined by Weeds Australia with the aim of controlling off-site movement. • Inspection of construction and operational vehicles and equipment for soil and vegetative material prior to entry to undisturbed areas. • implementation of a vehicle hygiene procedure, dieback management procedure and weed control. • Construction and operational vehicle and equipment movements limited to designated roads, access tracks and cleared areas.		

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			• Conceptual Clearing Area will be surveyed for Weeds of National Significance (WoNS), Declared and invasive weeds prior to clearing as part of Targeted surveys. • Weed monitoring will occur periodically, particularly in high-risk areas (stream zones and existing roads) and recorded weed infestations, so that any infestations that establish can be eradicated before the plants can flower and set seed • All identified WoNS and environmental weeds treated according to the weed control management outlined by Weeds Australia with the aim of controlling off-site movement. • Rehabilitation plants will only be sourced from nursery suppliers with appropriate weed control management.		

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Changes to fire regimes due to accidental fire or impacts DBCA prescribed burns schedule	Reduction in quality of conservation significant flora or communities resulting from changes in fire regime. Loss of biodiversity Loss or decline in fauna habitat quality	•	• Fire ban procedures - obey local enforcement and legislation. • Clearing around powerlines. • Emergency response process - Fire crews trained and equipment at hand (fire trucks etc.). • All heavy machinery has an in-built fire suppressant system.	•	Low